**NATURAL RESOURCES CONSERVATION SERVICE-VERMONT**

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## TABLE OF CONTENTS

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## PURPOSE

This guide has been developed for the use of field office personnel in order to assist them with design procedures normally completed at the field office level. Each conservation practice has been set up in such a way that the designer can follow an orderly and efficient method to complete the design. Sound planning procedures and a thorough soils investigation are prerequisites to quality designs. Form numbers sample computation sheet and reference exhibits are listed throughout the guide. The use of this guide is not intended as a substitution for the use of the Engineering Field Handbook or applicable standards and specifications. The use of this guide does not apply to designs that are more complex; i.e., ponds requiring state approval or complex structures.

Using this guide will be more efficient if this is kept in a three ring binder with the commonly used forms, tables and references inserted where needed.

"Preliminary investigations, preliminary reports, I&E's, etc., may be conducted and prepared by an employee who does not have approval authority for the kind and size of work involved; however, the work will be coordinated, reviewed for adequacy and completeness and approved by an employee having the required approval authority.

Planning, design, surveying and investigations, design development, drafting and specifications development may be performed by an employee who does not have approval authority for the kind and size of work involved; however, work performed in this manner will be done: (1) after authorization by an employee having the required approval authority; and (2) using the procedure specified." (210-V-NEM, Amend. VT11, November 1991 Page VT501-12 (2).

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## IMPORTANCE OF DESIGN (EFH chapter 5)

1. NRCS is recognized as an authority in this field of work.

2. Design provides detailed record of job to be done (will reflect planning decisions).

3. Provide copies of construction drawings and specifications for contractor and landowner.

4. Construction drawings and specifications are the basis of contract agreement between landowner and contractor.

5. Can be used as a legal document in case of a dispute.

## IMPORTANCE OF LAYOUT (EFH, pages 1-48.1 & 1-52)

1. Provides the contractor with references for lines and grades.

2. Assures that cuts and fills will follow design slopes.

3. May provide the opportunity to correct design errors and omissions.

4. May include a pre-construction conference on the more complicated jobs, or with new contractors. A pre-construction meeting is also a good time to **go over any applicable VOSHA regulations and NRCS safety requirements, as per part 210-V-NEM, Part 503-Safety, Amendment VT14, August, 1992.**

## IMPORTANCE OF CONSTRUCTION INSPECTION AND FINAL CHECK

1. Assures that the decisions made during planning and design are carried through to the final product.

2. Assures all parties concerned that the construction is of high quality and will meet all applicable design standards and construction specifications.

3. Protects the reputation of NRCS and reduces the chance of disputes.

4. Provides the basis for certification of practices that are cost shared, or financed entirely by the landowner.

5. Provides for design revision or alternation, should problems arise during construction, that were not foreseen in design.

6. Recording 'As-built' conditions which is becoming more important as a reference as time goes on.

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## SOILS INVESTIGATION (EFH Chapter 4, ASTM D2455)

Basis of Design for all conservation practices.

### Scope:

Engineering field identification of soils is based on the Unified Soil Classification System, Visual-Manual procedures. In this procedure, the identification portion assigning a group name and symbol is limited to soil particles smaller than 3 inches (75mm) and to naturally occurring soils. The investigator is the first person to see the soils in the practice area. The investigator should record all observations, which should become part of the cooperator's file and transfer the pertinent observations to the design. Agronomic descriptions are not appropriate for describing engineering properties of soils.

### INFORMATION REQUIRED:

Forms available: SCS-ENG-538
VT-ENG-14

1. Common to both coarse and fined grained soils

   a. Moisture Condition. <Dry, moist, wet and mottling or discoloration indicating seasonal high water table>

   b. Color, Munsel Color Chart is not necessary.

   c. Odor

2. Fine-grained properties (>50% passing #40 sieve).

   a. dry strength <Very high, high, medium, low or none>
   b. Dilatancy <Rapid, slow or none>
   c. toughness <High, medium or low>
   d. plasticity <High, medium, low or none>
   e. Consistency. <Very soft, soft, firm, hard or very hard> Inappropriate for soils with significant amounts of gravel.

   Tests will yield soil classifications of ML, CL, MH, CH, etc. with extra modifiers as needed. Do not skimp on descriptions, you are the only one to see the soil for design purposes.

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## SOILS INVESTIGATION (continued)

3. Coarse-grained properties (<50% passing #40 sieve).

   a. Angularity of particles (course sands and larger). <Angular, sub-angular, sub-rounded, rounded>

   b. Shape of gravel and larger particles. <Flat, elongated, flat and elongated, or not comment>

   c. Cementation for coarse-grained soils. <weak, moderate or strong>

   d. Sand and gravel sizes. <Sands: fine, medium or coarse><Gravels: sizes based on sizes passing sieve openings>

   e. "dirtiness"

Test will yield soil classifications of GW, SW, GP, SP, etc. with extra modifiers as needed.

4. Lab testing for permeability for soil liners, tests to request:

| | |
|---|---|
| a. Sieve Analysis | ASTM C117 and C136 |
| b. Atterberg Limits | ASTM D422 |
| c. Classification of Soils | ASTM D2487 |
| d. Standard Proctor | ASTM D698 |
| e. Flexiwall Permiability | ASTM D5084 |

   f. Other appropriate tests as needed

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## UNIFIED SOIL CLASSIFICATION

### FIELD INDENTIFICATION TESTS FOR FINE GRAINED SOILS

| Sample Number | Dilatancy | Toughness | Ribbon | Plasticity | Shine | Dry Strength | Class Symbol |
|---|---|---|---|---|---|---|---|
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# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## ESTIMATING RUNOFF AND PEAK DISCHARGES (EFH, Chapter 2)

**Purpose:** Basis of design for diversions, waterways, pond designs, culverts, etc.

### Information Required:

1. Determine rainfall frequency for practice from the Practice Standards (usually 10 year, 24 hour storm).

2. Determine drainage area in acres from USGS maps, aerial photographs or field observations.

3. Determine average watershed slope from USGS map, soils map or field measurements (average of several random slops in watershed).

4. Determine the flow length in feet from USGS map or aerial photographs or page n2-5 (1) EFH (longest flow path in the watershed from the watershed divide to the design point).

5. Determine soil type from soils maps or soils investigation to determine hydrologic soil group.

6. Determine land use in watershed from recent aerial photographs and field observations. Break down according to soil type (mapping units if mapped).

### Design Procedure:

Forms available: VT-ENG-1 - Time of Concentration and Peak Discharge
VT-ENG-15- Runoff Curve Number

1. From Exhibit 2-lA, EFH, select hydrologic soil group for each soil type and record on Form VT-ENG-15.

2. From Table 2-3a, b, c, d or e, EFH, pages 2-85 through N2-88 (1), select runoff curve numbers considering the land use and hydrologic condition of the watershed. Record on VT -ENG-15.

3. Calculate weighted runoff curve number (RCN) on VT-ENG-15 and record VT-ENG-1.

4. Rainfall distribution for Vermont is Type II.

5. Record drainage area in acres on Form VT-ENG-1.

6. Record average watershed slope and flow length on VT-ENG-1.

**ESTIMATING RUNOFF AND PEAK DISCHARGE** (Continued)

7. Record flow length on Form VT-ENG-1

8. Obtain $T_c$ from Figure 2-27, EFH page 2-41 or calculate using equation 2-5, EFH, page 2-5. Record on VT-ENG-1.

9. Record design frequency and rainfall on the bottom portion of VT-ENG-1.

10. Find initial abstraction Ia using RCN with Table 2-4, EFH page 2-89. Record on VT-ENG-1.

11. From Exhibit 2-3A, B, C. D, E or F, EFH, select rainfall depth for required design frequency and record on Form VT-ENG-1. Compute Ia/P ration and record on VT-ENG-1.

12. Find the unit peak discharge using $T_c$ and Ia/P ration with Exhibit 2-II, EFH page 2-13. Record on VT-ENG-1.

## ADDISON COUNTY (23)

| Town | 1 yr. | 2 yr. | 5 yr. | 10 yr. | 25 yr. | 50 yr. | 100 yr. |
|---|---|---|---|---|---|---|---|
| Addison | 2.1 | 2.3 | 3.2 | 3.6 | 4.2 | 4.7 | 5.0 |
| Bridport | 2.2 | 2.4 | 3.3 | 3.7 | 4.3 | 4.7 | 5.1 |
| Bristol | 2.2 | 2.3 | 3.2 | 3.7 | 4.3 | 4.7 | 5.1 |
| Cornwall | 2.2 | 2.4 | 3.3 | 3.7 | 4.3 | 4.8 | 5.2 |
| Ferrisburg | 2.1 | 2.3 | 3.2 | 3.6 | 4.2 | 4.7 | 4.9 |
| Goshen | 2.2 | 2.4 | 3.3 | 3.8 | 4.4 | 4.9 | 5.3 |
| Granville | 2.2 | 2.4 | 3.3 | 3.8 | 4.4 | 4.8 | 5.3 |
| Hancock | 2.2 | 2.4 | 3.3 | 3.8 | 4.4 | 4.9 | 5.3 |
| Leicester | 2.2 | 2.4 | 3.3 | 3.8 | 4.4 | 4.8 | 5.3 |
| Lincoln | 2.2 | 2.4 | 3.2 | 3.7 | 4.3 | 4.8 | 5.2 |
| Middlebury | 2.2 | 2.4 | 3.3 | 3.7 | 4.3 | 4.8 | 5.2 |
| Monkton | 2.1 | 2.3 | 3.2 | 3.6 | 4.2 | 4.7 | 5.0 |
| New Haven | 2.2 | 2.3 | 3.2 | 3.7 | 4.3 | 4.7 | 5.1 |
| Orwell | 2.2 | 2.4 | 3.3 | 3.7 | 4.4 | 4.8 | 5.3 |
| Panton | 2.1 | 2.3 | 3.2 | 3.6 | 4.2 | 4.7 | 5.0 |
| Ripton | 2.2 | 2.4 | 3.3 | 3.7 | 4.3 | 4.8 | 5.2 |
| Salsbury | 2.2 | 2.4 | 3.3 | 3.7 | 4.4 | 4.8 | 5.2 |
| Shoreham | 2.2 | 2.4 | 3.3 | 3.7 | 4.3 | 4.8 | 5.2 |
| Starksboro | 2.1 | 2.3 | 3.2 | 3.6 | 4.2 | 4.7 | 5.0 |
| Vergennes | 2.1 | 2.3 | 3.2 | 3.6 | 4.2 | 4.7 | 5.0 |
| Waltham | 2.1 | 2.3 | 3.2 | 3.7 | 4.2 | 4.7 | 5.0 |
| Weybridge | 2.2 | 2.3 | 3.2 | 3.7 | 4.3 | 4.7 | 5.1 |
| Whiting | 2.2 | 2.4 | 3.3 | 3.7 | 4.4 | 4.8 | 5.2 |

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## BENNINGTON COUNTY (17)

| Town | 1 yr. | 2 yr. | 5 yr. | 10 yr. | 25 yr. | 50 yr. | 100 yr. |
|---|---|---|---|---|---|---|---|
| Arlington | 2.3 | 2.7 | 3.5 | 4.0 | 4.7 | 5.2 | 5.8 |
| Bennington | 2.3 | 2.7 | 3.6 | 4.0 | 4.8 | 5.3 | 5.9 |
| Dorset | 2.3 | 2.6 | 3.5 | 4.0 | 4.7 | 5.1 | 5.7 |
| Glastonbury | 2.3 | 2.7 | 3.5 | 4.0 | 4.8 | 5.3 | 5.9 |
| Landgrove | 2.3 | 2.6 | 3.5 | 4.0 | 4.7 | 5.2 | 5.8 |
| Manchester | 2.3 | 2.7 | 3.5 | 4.0 | 4.7 | 5.2 | 5.8 |
| Peru | 2.3 | 2.6 | 3.5 | 4.0 | 4.7 | 5.2 | 5.8 |
| Pownal | 2.3 | 2.8 | 3.6 | 4.1 | 4.8 | 5.4 | 6.0 |
| Readsboro | 2.4 | 2.8 | 3.7 | 4.1 | 4.9 | 5.4 | 6.1 |
| Rupert | 2.3 | 2.6 | 3.4 | 3.9 | 4.6 | 5.1 | 5.7 |
| Sandgate | 2.3 | 2.6 | 3.5 | 4.0 | 4.7 | 5.1 | 5.7 |
| Searsburg | 2.3 | 2.7 | 3.6 | 4.1 | 4.8 | 5.4 | 6.0 |
| Shaftsbury | 2.3 | 2.7 | 3.5 | 4.0 | 4.8 | 5.2 | 5.8 |
| Stanford | 2.3 | 2.8 | 3.6 | 4.1 | 4.9 | 5.4 | 6.0 |
| Sunderland | 2.3 | 2.7 | 3.5 | 4.0 | 4.7 | 5.2 | 5.9 |
| Winhall | 2.3 | 2.7 | 3.5 | 4.0 | 4.7 | 5.2 | 5.8 |
| Woodford | 2.3 | 2.7 | 3.0 | 4.1 | 4.8 | 5.4 | 6.0 |

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## CALEDONIA COUNTY

| Town | 1 yr. | 2 yr. | 5 yr. | 10 yr. | 25 yr. | 50 yr. | 100 yr. |
|---|---|---|---|---|---|---|---|
| Barnet | 2.2 | 2.4 | 3.3 | 3.8 | 4.5 | 4.9 | 5.4 |
| Burke | 2.2 | 2.4 | 3.2 | 3.8 | 4.6 | 4.8 | 5.2 |
| Danville | 2.2 | 2.4 | 3.3 | 3.8 | 4.5 | 4.9 | 5.3 |
| Groton | 2.2 | 2.4 | 3.3 | 3.8 | 4.4 | 4.9 | 5.3 |
| Hardwick | 2.2 | 2.3 | 3.2 | 3.7 | 4.3 | 4.7 | 5.1 |
| Kirby | 2.2 | 2.4 | 3.3 | 3.8 | 4.6 | 4.9 | 5.4 |
| Lyndon | 2.2 | 2.4 | 3.3 | 3.8 | 4.6 | 4.8 | 5.3 |
| Newark | 2.2 | 2.3 | 3.2 | 3.7 | 4.5 | 4.8 | 5.1 |
| Peacham | 2.2 | 2.4 | 3.3 | 3.8 | 4.4 | 4.9 | 5.3 |
| Ryegate | 2.2 | 2.4 | 3.4 | 3.8 | 4.5 | 5.0 | 5.4 |
| Sheffield | 2.2 | 2.3 | 3.2 | 3.7 | 4.4 | 4.7 | 5 |
| St. Johnsbury | 2.2 | 2.4 | 3.3 | 3.8 | 4.6 | 4.9 | 5.4 |
| Standard | 2.2 | 2.3 | 3.2 | 3.8 | 4.4 | 4.8 | 5.1 |
| Sutton | 2.2 | 2.3 | 3.2 | 3.7 | 4.5 | 4.8 | 5 |
| Walden | 2.2 | 2.4 | 3.2 | 3.7 | 4.4 | 4.8 | 5.2 |
| Waterford | 2.2 | 2.4 | 3.3 | 3.8 | 4.6 | 5.0 | 5.5 |
| Wheelock | 2.2 | 2.3 | 3.2 | 3.7 | 4.4 | 4.8 | 5.1 |

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## CITTENDEN COUNTY

| Town | 1 yr. | 2 yr. | 5 yr. | 10 yr. | 25 yr. | 50 yr. | 100 yr. |
|---|---|---|---|---|---|---|---|
| Bolton | 2.1 | 2.3 | 3.2 | 3.6 | 4.2 | 4.6 | 4.9 |
| Buels Gore | 2.2 | 2.3 | 3.2 | 3.7 | 4.3 | 4.7 | 5.1 |
| Burlington | 2.1 | 2.2 | 3.1 | 3.5 | 4.1 | 4.5 | 4.8 |
| Charlotte | 2.1 | 2.3 | 3.2 | 3.6 | 4.1 | 4.6 | 4.9 |
| Colchester | 2.1 | 2.2 | 3.1 | 3.5 | 4.1 | 4.5 | 4.7 |
| Essex | 2.1 | 2.2 | 3.2 | 3.5 | 4.1 | 4.5 | 4.8 |
| Hinesburg | 2.1 | 2.3 | 3.2 | 3.6 | 4.2 | 4.6 | 4.9 |
| Huntington | 2.1 | 2.3 | 3.2 | 3.6 | 4.2 | 4.7 | 5.0 |
| Jericho | 2.1 | 2.3 | 3.1 | 3.6 | 4.1 | 4.6 | 4.8 |
| Milton | 2.1 | 2.2 | 3.1 | 3.5 | 4.0 | 4.5 | 4.7 |
| Richmond | 2.1 | 2.3 | 3.2 | 3.6 | 4.2 | 4.6 | 4.9 |
| S. Burlington | 2.1 | 2.3 | 3.1 | 3.6 | 4.1 | 4.6 | 4.8 |
| Shelburne | 2.1 | 2.3 | 3.1 | 3.6 | 4.1 | 4.6 | 4.8 |
| St. George | 2.1 | 2.3 | 3.2 | 3.6 | 4.1 | 4.6 | 4.9 |
| Underhill | 2.1 | 2.2 | 3.1 | 3.5 | 4.1 | 4.6 | 4.8 |
| Westford | 2.1 | 2.2 | 3.1 | 3.5 | 4.1 | 4.5 | 4.8 |
| Williston | 2.1 | 2.3 | 3.1 | 3.6 | 4.1 | 4.6 | 4.8 |

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## ESSEX COUNTY (19)

| Town | 1 yr. | 2 yr. | 5 yr. | 10 yr. | 25 yr. | 50 yr. | 100 yr. |
|---|---|---|---|---|---|---|---|
| Averill | 2.2 | 2.3 | 3.1 | 3.7 | 4.6 | 4.8 | 5.0 |
| Avery's Gore | 2.2 | 2.3 | 3.1 | 3.6 | 4.5 | 4.7 | 5.0 |
| Broomfield | 2.2 | 2.4 | 3.2 | 3.8 | 4.7 | 4.8 | 5.2 |
| Brighton | 2.2 | 2.3 | 3.2 | 3.7 | 4.5 | 4.8 | 5.0 |
| Brunswick | 2.2 | 2.4 | 3.3 | 3.8 | 4.7 | 4.9 | 5.3 |
| Canaan | 2.2 | 2.3 | 3.2 | 3.7 | 4.6 | 4.8 | 5.0 |
| Concord | 2.2 | 2.4 | 3.4 | 3.9 | 4.7 | 5.0 | 5.6 |
| East Haven | 2.2 | 2.4 | 3.3 | 3.8 | 4.6 | 4.9 | 5.3 |
| Ferdinand | 2.2 | 2.4 | 3.2 | 3.8 | 4.6 | 4.9 | 5.2 |
| Granby | 2.2 | 2.4 | 3.3 | 3.9 | 4.7 | 4.9 | 5.5 |
| Guildhall | 2.2 | 2.4 | 3.4 | 3.9 | 4.8 | 5.0 | 5.6 |
| Lemington | 2.2 | 2.3 | 3.2 | 3.8 | 4.6 | 4.8 | 5.1 |
| Lewis | 2.2 | 2.3 | 3.2 | 3.7 | 4.6 | 4.8 | 5.0 |
| Lunenburg | 2.2 | 2.4 | 3.4 | 3.9 | 4.8 | 5.0 | 5.6 |
| Maidstone | 2.2 | 2.4 | 3.3 | 3.9 | 4.8 | 4.9 | 5.5 |
| Norton | 2.2 | 2.3 | 3.1 | 3.6 | 4.5 | 4.7 | 4.9 |
| Victory | 2.2 | 2.4 | 3.3 | 3.8 | 4.7 | 4.9 | 5.4 |
| Warner's Gore | 2.2 | 2.3 | 3.1 | 3.6 | 4.5 | 4.7 | 4.9 |
| Warner's Grant | 2.2 | 2.3 | 3.1 | 3.6 | 4.4 | 4.7 | 4.9 |

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## FRANKLIN COUNTY (14)

| Town | 1 yr. | 2 yr. | 5 yr. | 10 yr. | 25 yr. | 50 yr. | 100 yr. |
|---|---|---|---|---|---|---|---|
| Bakersfield | 2.1 | 2.2 | 3.1 | 3.5 | 4.1 | 4.4 | 4.7 |
| Berkshire | 2.1 | 2.1 | 3.0 | 3.4 | 4.0 | 4.4 | 4.6 |
| Enosburg | 2.1 | 2.2 | 3.0 | 3.4 | 4.0 | 4.4 | 4.7 |
| Fairfax | 2.1 | 2.2 | 3.1 | 3.5 | 4.0 | 4.5 | 4.7 |
| Fairfield | 2.1 | 2.2 | 3.1 | 3.4 | 4.0 | 4.4 | 4.7 |
| Fletcher | 2.1 | 2.2 | 3.1 | 3.5 | 4.1 | 4.5 | 4.7 |
| Franklin | 2.0 | 2.1 | 3.0 | 3.4 | 4.0 | 4.3 | 4.6 |
| Georgia | 2.1 | 2.2 | 3.1 | 3.4 | 4.0 | 4.4 | 4.6 |
| Highgate | 2.0 | 2.1 | 3.0 | 3.4 | 3.9 | 4.3 | 4.5 |
| Montgomery | 2.1 | 2.2 | 3.1 | 3.4 | 4.1 | 4.4 | 4.7 |
| Richford | 2.1 | 2.2 | 3.0 | 3.4 | 4.0 | 4.4 | 4.7 |
| Sheldon | 2.0 | 2.1 | 3.0 | 3.4 | 4.0 | 4.4 | 4.6 |
| St. Albans | 2.0 | 2.1 | 3.0 | 3.4 | 4.0 | 4.4 | 4.6 |
| Swanton | 2.0 | 2.1 | 3.0 | 3.4 | 3.9 | 4.3 | 4.6 |

## GRAND ISLE COUNTY (5)

| Town | 1 yr. | 2 yr. | 5 yr. | 10 yr. | 25 yr. | 50 yr. | 100 yr. |
|---|---|---|---|---|---|---|---|
| Alburg | 2.0 | 2.1 | 3.0 | 3.4 | 3.9 | 4.3 | 4.5 |
| Grand Isle | 2.0 | 2.1 | 3.1 | 3.4 | 4.0 | 4.4 | 4.6 |
| Isle Lamotte | 2.0 | 2.1 | 3.0 | 3.4 | 3.9 | 4.3 | 4.5 |
| North Hero | 2.0 | 2.1 | 3.0 | 3.4 | 3.9 | 4.3 | 4.5 |
| South Hero | 2.1 | 2.2 | 3.1 | 3.5 | 4.0 | 4.4 | 4.6 |

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## LAMOILLE COUNTY (10)

| Town | 1 yr. | 2 yr. | 5 yr. | 10 yr. | 25 yr. | 50 yr. | 100 yr. |
|---|---|---|---|---|---|---|---|
| Belvidere | 2.1 | 2.2 | 3.1 | 3.5 | 4.1 | 4.5 | 4.8 |
| Cambridge | 2.1 | 2.2 | 3.1 | 3.5 | 4.1 | 4.5 | 4.8 |
| Eden | 2.1 | 2.2 | 3.1 | 3.5 | 4.2 | 4.6 | 4.8 |
| Elmore | 2.2 | 2.3 | 3.2 | 3.6 | 4.3 | 4.7 | 5.0 |
| Hyde Park | 2.1 | 2.3 | 3.1 | 3.6 | 4.2 | 4.6 | 4.9 |
| Johnson | 2.1 | 2.2 | 3.1 | 3.5 | 4.1 | 4.6 | 4.8 |
| Morristown | 2.1 | 2.3 | 3.2 | 3.6 | 4.2 | 4.6 | 4.9 |
| Stowe | 2.1 | 2.3 | 3.2 | 3.6 | 4.2 | 4.6 | 4.9 |
| Waterville | 2.1 | 2.2 | 3.1 | 3.5 | 4.1 | 4.5 | 4.8 |
| Wolcott | 2.1 | 2.3 | 3.2 | 3.6 | 4.3 | 4.7 | 5.0 |

## ORANGE COUNTY (17)

| Town | 1 yr. | 2 yr. | 5 yr. | 10 yr. | 25 yr. | 50 yr. | 100 yr. |
|---|---|---|---|---|---|---|---|
| Bradford | 2.3 | 2.5 | 3.4 | 3.9 | 4.5 | 5.0 | 5.3 |
| Braintree | 2.2 | 2.4 | 3.3 | 3.8 | 4.4 | 4.9 | 5.4 |
| Brookfield | 2.2 | 2.4 | 3.3 | 3.8 | 4.4 | 4.9 | 5.4 |
| Chelsea | 2.2 | 2.5 | 3.3 | 3.8 | 4.5 | 5.0 | 5.4 |
| Corinth | 2.2 | 2.5 | 3.4 | 3.9 | 4.5 | 5.0 | 5.4 |
| Fairlee | 2.3 | 2.5 | 3.4 | 3.9 | 4.6 | 5.1 | 5.6 |
| Newbury | 2.2 | 2.5 | 3.4 | 3.9 | 4.5 | 4.9 | 5.5 |
| Orange | 2.2 | 2.4 | 3.3 | 3.8 | 4.4 | 4.9 | 5.3 |
| Randolph | 2.2 | 2.5 | 3.4 | 3.8 | 4.4 | 4.9 | 5.4 |
| Straford | 2.3 | 2.5 | 3.4 | 3.9 | 4.5 | 5.0 | 5.5 |
| Thetford | 2.3 | 2.5 | 3.5 | 3.9 | 4.6 | 5.1 | 5.6 |
| Topsham | 2.2 | 2.4 | 3.3 | 3.8 | 4.5 | 4.9 | 5.4 |
| Tunbridge | 2.2 | 2.5 | 3.4 | 3.9 | 4.5 | 5.0 | 5.5 |
| Vershire | 2.2 | 2.5 | 3.4 | 3.9 | 4.5 | 5.0 | 5.5 |
| Washington | 2.2 | 2.4 | 3.3 | 3.8 | 4.4 | 4.9 | 5.4 |
| West Fairlee | 2.3 | 2.5 | 3.4 | 3.9 | 4.5 | 5.0 | 5.5 |
| Williamstown | 2.2 | 2.4 | 3.3 | 3.8 | 4.4 | 4.9 | 5.3 |

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## ORLEANS COUNTY (18)

| Town | 1 yr. | 2 yr. | 5 yr. | 10 yr. | 25 yr. | 50 yr. | 100 yr. |
|---|---|---|---|---|---|---|---|
| Albany | 2.1 | 2.3 | 3.1 | 3.5 | 4.3 | 4.6 | 4.9 |
| Barton | 2.1 | 2.3 | 3.1 | 3.6 | 4.4 | 4.7 | 4.9 |
| Brownington | 2.1 | 2.3 | 3.1 | 3.6 | 4.4 | 4.6 | 4.9 |
| Charleston | 2.1 | 2.3 | 3.1 | 3.6 | 4.4 | 4.7 | 4.9 |
| Coventry | 2.1 | 2.2 | 3.1 | 3.5 | 4.3 | 4.6 | 4.8 |
| Craftsbury | 2.1 | 2.3 | 3.1 | 3.6 | 4.3 | 4.6 | 4.9 |
| derby | 2.1 | 2.2 | 3.1 | 3.5 | 4.3 | 4.6 | 4.8 |
| Glover | 2.1 | 2.3 | 3.2 | 3.6 | 4.4 | 4.7 | 5.0 |
| Greensboro | 2.2 | 2.3 | 3.2 | 3.6 | 4.3 | 4.7 | 5.0 |
| Holland | 2.1 | 2.2 | 3.1 | 3.5 | 4.4 | 4.6 | 4.9 |
| Irasburg | 2.1 | 2.2 | 3.1 | 3.5 | 4.3 | 4.6 | 4.9 |
| Jay | 2.1 | 2.2 | 3.0 | 3.4 | 4.1 | 4.4 | 4.7 |
| Lowell | 2.1 | 2.2 | 3.1 | 3.5 | 4.2 | 4.5 | 4.8 |
| Morgan | 2.1 | 2.3 | 3.1 | 3.6 | 4.4 | 4.7 | 4.9 |
| Newport | 2.1 | 2.2 | 3.1 | 3.4 | 4.2 | 4.5 | 4.8 |
| Troy | 2.1 | 2.2 | 3.0 | 3.4 | 4.1 | 4.5 | 4.8 |
| Westfield | 2.1 | 2.2 | 3.1 | 3.4 | 4.1 | 4.5 | 4.8 |
| Westmore | 2.2 | 2.3 | 3.2 | 3.6 | 4.4 | 4.7 | 5.0 |

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## RUTLAND COUNTY (27)

| Town | 1 yr. | 2 yr. | 5 yr. | 10 yr. | 25 yr. | 50 yr. | 100 yr. |
|---|---|---|---|---|---|---|---|
| Benson | 2.2 | 2.4 | 3.3 | 3.8 | 4.4 | 4.8 | 5.3 |
| Brandon | 2.2 | 2.4 | 3.3 | 3.8 | 4.4 | 4.9 | 5.3 |
| Castleton | 2.2 | 2.5 | 3.3 | 3.8 | 4.5 | 4.9 | 5.4 |
| Chittenden | 2.2 | 2.5 | 3.3 | 3.8 | 4.5 | 4.9 | 5.4 |
| Clarendon | 2.3 | 2.5 | 3.4 | 3.9 | 4.5 | 5.0 | 5.6 |
| Danby | 2.3 | 2.6 | 3.4 | 3.9 | 4.6 | 5.1 | 5.7 |
| Fair Haven | 2.2 | 2.5 | 3.3 | 3.8 | 4.5 | 4.9 | 5.4 |
| Hubbardton | 2.2 | 2.4 | 3.3 | 3.8 | 4.4 | 4.9 | 5.4 |
| Ira | 2.2 | 2.5 | 3.4 | 3.9 | 4.5 | 5.0 | 5.5 |
| Mendon | 2.3 | 2.5 | 3.4 | 3.9 | 4.5 | 5.0 | 5.5 |
| Middletown | 2.2 | 2.5 | 3.4 | 3.9 | 4.5 | 5.0 | 5.5 |
| Mount Holly | 2.3 | 2.6 | 3.5 | 4.0 | 4.6 | 5.1 | 5.7 |
| Mount Tabor | 2.3 | 2.6 | 3.5 | 4.0 | 4.6 | 5.1 | 5.7 |
| Pawlet | 2.3 | 2.6 | 3.4 | 3.9 | 4.6 | 5.0 | 5.6 |
| Pittsfield | 2.2 | 2.5 | 3.3 | 3.8 | 4.5 | 4.9 | 5.4 |
| Pittsford | 2.2 | 2.5 | 3.3 | 3.8 | 4.5 | 4.9 | 5.4 |
| Poultney | 2.2 | 2.5 | 3.4 | 3.9 | 4.5 | 5.0 | 5.5 |
| Proctor | 2.2 | 2.5 | 3.4 | 3.8 | 4.5 | 4.9 | 5.5 |
| Rutland | 2.2 | 2.5 | 3.4 | 3.9 | 4.5 | 5.0 | 5.5 |
| Sherburne | 2.3 | 2.5 | 3.4 | 3.9 | 4.5 | 5.0 | 5.5 |
| Shrewsbury | 2.3 | 2.6 | 3.4 | 3.9 | 4.6 | 5.0 | 5.6 |
| Sudbury | 2.2 | 2.4 | 3.3 | 3.8 | 4.4 | 4.8 | 5.3 |
| Tinmouth | 2.3 | 2.6 | 3.4 | 3.9 | 4.6 | 5.0 | 5.6 |
| Wallingford | 2.3 | 2.6 | 3.4 | 3.9 | 4.6 | 5.1 | 5.6 |
| Wells | 2.3 | 2.5 | 3.4 | 3.9 | 4.5 | 5.0 | 5.6 |
| West Haven | 2.2 | 2.4 | 3.3 | 3.8 | 4.4 | 4.9 | 5.4 |
| West Rutland | 2.2 | 2.5 | 3.4 | 3.8 | 4.5 | 5.0 | 5.5 |

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## WASHINGTON COUNTY (19)

| Town | 1 yr. | 2 yr. | 5 yr. | 10 yr. | 25 yr. | 50 yr. | 100 yr. |
|---|---|---|---|---|---|---|---|
| Barre | 2.2 | 2.3 | 3.3 | 3.6 | 4.4 | 4.9 | 5.3 |
| Berlin | 2.2 | 2.4. | 3.3 | 3.7 | 4.3 | 4.8 | 5.2 |
| Cabot | 2.2 | 2.4. | 3.3 | 3.7 | 4.4 | 4.8 | 5.2 |
| Calais | 2.2 | 2.4. | 3.2 | 3.7 | 4.3 | 4.8 | 5.1 |
| Duxbury | 2.2 | 2.3 | 3.2 | 3.6 | 4.2 | 4.7 | 5.0 |
| East Montpelier | 2.2 | 2.4. | 3.3 | 3.7 | 4.3 | 4.8 | 5.2 |
| Fayston | 2.2 | 2.4. | 3.2 | 3.7 | 4.3 | 4.7 | 5.1 |
| Marshfield | 2.2 | 2.4. | 3.3 | 3.7 | 4.4 | 4.8 | 5.2 |
| Middlesex | 2.2 | 2.3 | 3.2 | 3.7 | 4.3 | 4.7 | 5.1 |
| Montpelier | 2.2 | 2.4. | 3.2 | 3.7 | 4.3 | 4.8 | 5.2 |
| Moretown | 2.2 | 2.4. | 3.2 | 3.7 | 4.3 | 4.8 | 5.1 |
| Northfield | 2.2 | 2.4. | 3.3 | 3.7 | 4.3 | 4.8 | 5.2 |
| Plainfield | 2.2 | 2.3 | 3.3 | 3.6 | 4.4 | 4.8 | 5.3 |
| Roxbury | 2.2 | 2.4. | 3.3 | 3.7 | 4.4 | 4.8 | 5.3 |
| Waitsfield | 2.2 | 2.3 | 3.2 | 3.7 | 4.3 | 4.8 | 5.2 |
| Warren | 2.2 | 2.4. | 3.2 | 3.7 | 4.3 | 4.8 | 5.2 |
| Waterbury | 2.1 | 2.3 | 3.2 | 3.6 | 4.2 | 4.7 | 5.0 |
| Woodbury | 2.2 | 2.3 | 3.2 | 3.7 | 4.3 | 4.8 | 5.1 |
| Worcester | 2.2 | 2.3 | 3.2 | 3.6 | 4.3 | 4.7 | 5.0 |

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## WINDHAM COUNTY (23)

| Town | 1 yr. | 2 yr. | 5 yr. | 10 yr. | 25 yr. | 50 yr. | 100 yr. |
|---|---|---|---|---|---|---|---|
| Athens | 2.3 | 2.7 | 3.6 | 4.1 | 4.8 | 5.3 | 6.0 |
| Brattleboro | 2.4 | 2.8 | 3.7 | 4.1 | 4.9 | 5.5 | 6.2 |
| Brookline | 2.4 | 2.7 | 3.7 | 4.1 | 4.8 | 5.4 | 6.1 |
| Dover | 2.3 | 2.7 | 3.6 | 4.1 | 4.8 | 5.4 | 6.0 |
| Dummerston | 2.4 | 2.8 | 3.7 | 4.1 | 4.9 | 5.4 | 6.1 |
| Grafton | 2.3 | 2.7 | 3.6 | 4.1 | 4.8 | 5.3 | 6.0 |
| Guilford | 2.4 | 2.8 | 3.7 | 4.2 | 4.9 | 5.5 | 6.2 |
| Halifax | 2.4 | 2.8 | 3.7 | 4.1 | 4.9 | 5.5 | 6.2 |
| Jamaica | 2.3 | 2.7 | 3.6 | 4.1 | 4.8 | 5.3 | 5.9 |
| Londonderry | 2.3 | 2.7 | 3.5 | 4.0 | 4.7 | 5.2 | 5.9 |
| Marlboro | 2.4 | 2.8 | 3.7 | 4.1 | 4.9 | 5.4 | 6.1 |
| Newfane | 2.4 | 2.8 | 3.7 | 4.1 | 4.8 | 5.4 | 6.1 |
| Putney | 2.4 | 2.8 | 3.7 | 4.1 | 4.9 | 5.4 | 6.1 |
| Rockingham | 2.3 | 2.7 | 3.6 | 4.1 | 4.8 | 5.3 | 6.0 |
| Somerset | 2.3 | 2.7 | 3.6 | 4.1 | 4.8 | 5.3 | 6.0 |
| Stratton | 2.3 | 2.7 | 3.6 | 4.0 | 4.8 | 5.3 | 5.9 |
| Townshend | 2.3 | 2.7 | 3.6 | 4.1 | 4.8 | 5.3 | 6.0 |
| Vernon | 2.4 | 2.8 | 3.7 | 4.2 | 5.0 | 5.5 | 6.3 |
| Wardsboro | 2.3 | 2.7 | 3.6 | 4.1 | 4.8 | 5.3 | 6.0 |
| Westminster | 2.4 | 2.7 | 3.7 | 4.1 | 4.8 | 5.4 | 6.1 |
| Whitingham | 2.4 | 2.8 | 3.7 | 4.1 | 4.9 | 5.5 | 6.1 |
| Wilmington | 2.4 | 2.8 | 3.7 | 4.1 | 4.9 | 5.4 | 6.1 |
| Windham | 2.3 | 2.7 | 3.6 | 4.0 | 4.8 | 5.3 | 5.9 |

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## WINDSOR COUNTY (23)

| Town | 1 yr. | 2 yr. | 5 yr. | 10 yr. | 25 yr. | 50 yr. | 100 yr. |
|---|---|---|---|---|---|---|---|
| Andover | 2.3 | 2.7 | 3.5 | 4.0 | 4.7 | 5.2 | 5.8 |
| Barnard | 2.3 | 2.5 | 3.4 | 3.9 | 4.5 | 5.0 | 5.6 |
| Bethel | 2.2 | 2.5 | 3.3 | 3.8 | 4.5 | 5.0 | 5.4 |
| Bridgewater | 2.3 | 2.5 | 3.4 | 3.9 | 4.6 | 5.1 | 5.6 |
| Cavendish | 2.3 | 2.6 | 3.5 | 4.0 | 4.7 | 5.2 | 5.8 |
| Chester | 2.3 | 2.7 | 3.5 | 4.0 | 4.7 | 5.2 | 5.9 |
| Hartford | 2.3 | 2.6 | 3.5 | 4.0 | 4.6 | 5.1 | 5.7 |
| Hartland | 2.3 | 2.6 | 3.5 | 4.0 | 4.6 | 5.1 | 5.7 |
| Ludlow | 2.3 | 2.6 | 3.5 | 4.0 | 4.7 | 5.2 | 5.8 |
| Norwich | 2.3 | 2.5 | 3.5 | 3.9 | 4.6 | 5.1 | 5.7 |
| Plymouth | 2.3 | 2.6 | 3.4 | 3.9 | 4.6 | 5.1 | 5.7 |
| Pomfret | 2.3 | 2.5 | 3.4 | 3.9 | 4.6 | 5.1 | 5.6 |
| Reading | 2.3 | 2.6 | 3.5 | 4.0 | 4.6 | 5.1 | 5.7 |
| Rochester | 2.2 | 2.4 | 3.3 | 3.8 | 4.4 | 4.9 | 5.4 |
| Royalton | 2.3 | 2.5 | 3.4 | 3.9 | 4.5 | 5.0 | 5.5 |
| Sharon | 2.3 | 2.5 | 3.4 | 3.9 | 4.5 | 5.0 | 5.6 |
| Springfield | 2.3 | 2.7 | 3.6 | 4.1 | 4.7 | 5.3 | 5.9 |
| Stockbridge | 2.2 | 2.5 | 3.4 | 3.8 | 4.5 | 5.0 | 5.5 |
| Weathersfield | 2.3 | 2.7 | 3.6 | 4.0 | 4.7 | 5.2 | 5.9 |
| West Windsor | 2.3 | 2.6 | 3.5 | 4.0 | 4.7 | 5.2 | 5.8 |
| Weston | 2.3 | 2.6 | 3.5 | 4.0 | 4.7 | 5.2 | 5.8 |
| Windsor | 2.3 | 2.6 | 3.5 | 4.0 | 4.7 | 5.2 | 5.8 |
| Woodstock | 2.3 | 2.6 | 3.5 | 3.9 | 4.6 | 5.1 | 5.7 |

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## **DIVERSIONS** (Code 362, EFH, Chapter 9)

**Purpose** - To divert surface water from areas where it is in excess to sites where it can be used or disposed of safely. Use in conjunction with strips, also provides drainage on very shallow soils.

### Information Required:

1. Survey centerline, maximum 100 feet intervals. Set centerline stakes on desired grade and straighten line for workability. Take cross sections as needed, no more than 500' apart.

2. Design Discharge (Refer to Practice Standard 362-Diversion and EFH Table 9.2, Page 9-10, Chapter 2).

3. Judgment concerning type condition and time of year for vegetation to be established, refer to Practice Standard 342-Critical Area Planting.

4. Soil type.

5. Plan adequate outlet (waterway, underground outlet, natural watercourse, etc.).

### Design Procedure

Forms available: VT-ENG-1 - Time of Concentration and Peak Discharge
VT-ENG-15- Runoff Curve Number
VT-ENG-13- Diversion-Waterway Design

1. Plot profile to determine design grades.

2. Use the Vermont Drainage Guide to choose permissible velocity for bare channel and design capacity for fully vegetated condition.

3. From Table 9-1, EFH, page 9-8, determine retardance for stability and capacity and record. Generally, use 'D' retardance for velocity stability check and 'C' retardance for capacity check.

4. From Table 9-1, EFH, page 9-8, select permissible velocity. Use Vermont Drainage Guide if applicable.

5. From Exhibit 9-1 through 9-4, pages 9-17 through 9-48 EFH select channel width and depth.

5. Complete formVT-ENG-13, Diversion-Waterway Design.

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## DIVERSIONS (continued)

6. Determine if there is an adequate volume of excavation (cut) to construct the berm.

7. Check for location of public and private utilities in accordance with Part 503 of the National Engineering Manual. Locate and describe on construction drawings.

8. Complete a bill of materials.

### Construction Layout:

1. Center line station or offset stakes graded for cut. Layout of spreader if needed.

2. Provide copies of plans and specifications to landowner.

### Construction Inspection:

1. Make sure area under berm has been stripped of all organic material.

2. Construction checks to insure compliance with design grades and cross-section.

3. Check to assure that proper materials and methods for establishing vegetation are being used.

### Final Check:

1. Record supporting data in accordance with the General Manual (Title 450, Part 407).

2. Plot 'As-built' in red on plans, sign and date. Plot the finished profile and cross-sections.

3. Mark the Conservation Planning Map

4. Check off Practice on Conservation Plan and date completion.

5. Record in CON-6 Notes.

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## **GRASSED WATERWAY OR OUTLET** (Code 412, EFH, Chapter 7)

**Purpose**: To dispose of excess surface water from terraces, diversions, or from natural concentrations without erosion or flooding, may require stone center.

### Information Required:

1. Survey centerline and cross-sections. Use judgment as to the amount of detail needed. Cross-sections for waterways are more critical than for diversions.

2. Design Discharge (minimum 10-year frequency, EFH Chapter 2).

3. Judgment concerning type and condition of cover vegetation to be established and time of year for construction.

4. Determine if subsurface drainage is required due to constant or long duration flow which would prevent the establishment of vegetation (refer to Practice Standard 342-Critical Area Planting).

### Design Procedure:

Forms available: VT-ENG-1 - Time of Concentration and Peak Discharge
VT-ENG-15- Runoff Curve Number
VT-ENG-13- Diversion-Waterway Design

1. Plot profile and cross-sections to determine design grade and depth for various sections.

2. Using Vermont Drainage Guide if applicable and Exhibit 7-3, EFH, page 7-19, determine and record permissible velocity on Form VT-ENG-13.

3. Using Exhibit 7-2, EFH, page 7-18; determine retardance for stability and capacity and record. Generally, use 'D' retardance for velocity stability check and 'C' retardance for capacity check. If the channel needs to be lined, refer to Exhibit 7-6, EFH, pages 7-48.

4. From Exhibit 7-4 and 7-5, EFH, pages 7-20 through 7-47, select channel size.

5. Complete VT-ENG-13, Diversion - Waterway Design.

6. Select a design that will best fit the surveyed cross-sections.

7. Check for location of public and private utilities in accordance with Part 503 of the National Engineering Manual. Locate and describe on construction drawings.

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## GRASSED WATERWAY OR OUTLET (Continued)

### Construction Layout:

1. Center line station or offset stakes graded for cut.

2. Provide copies of plans and specifications to landowner.

### Construction Inspection:

1. Check construction to insure compliance with design grades and cross-section.

2. Check to assure that proper materials and methods for establishing vegetation are being used.

3. Check for proper stone sizes if waterway is lined.

### Final Check:

1. Record supporting data in accordance with the General Manual (Title 450, Part 407).

2. Plot 'As-built' in red on plans, sign and date. Plot the finished profile and cross-sections.

3. Mark the Conservation Planning Map

4. Check off Practice on Conservation Plan and date completion.

5. Record in CON-6 Notes.

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## **SUBSURFACE DRAIN** (Code 606, EFH, Chapter 14)

**Purpose** - Lower water table, intercept subsurface flows.

### Information Required:

1. Drainage area and soil type.

2. Location and length of main and lateral(s) to effect desired drainage.

3. Survey centerline. Use judgment as to amount of detail needed. Note: Surveys are not required for random lines that are 1500 feet or less in length and S = 0.010 (1%) or more in grade.

4. Plan of adequate outlet.

### **Design Procedure**:

Forms available: VT-ENG-1 - Time of Concentration and Peak Discharge
VT-ENG-15- Runoff Curve Number
VT-ENG-17- Subsurface Drainage Design

1. Sketch of complete layout.

2. Plot centerline survey notes.

3. Determine method of design (inflow rate or drainage area).

4. From Table 14-7, page 14-71, EFH, check for filter and envelop requirements.

5. Check design criteria in Vermont Drainage Guide.

6. Select tile size from Exhibits 14-11.1, 14-11.2 or 14-11.3 found on pages 14-108.1 through 14-108.3, EFH. Be sure that requirements for the main include all laterals that enter above the design point.

7. Prepare design sheet VT-ENG-17. Provide special requirements. Protection of outlet from erosion and/or sloughing is very important.

8. Complete bill of materials.

9. Check for location of public or private utilities in accordance with Part 503 of the National Engineering Manual. Locate and describe on construction drawings.

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## SUBSURFACE DRAIN (continued)

10. For steep slopes, provide vents or breathers to prevent 'piping' of soil.

### Construction Layout:

1. Offset stakes marked with appropriate cut.

2. Provide copies of plans and specifications to landowner.

### Construction Inspection:

1. Field check to insure compliance with design grades and/or depth and proper location of laterals.

2. Check to insure adequacy of outlet.

3. Check type and quality of material being used.

4. Check method of back-filling, use of filter material and installation of special details (i.e., breathers, animal guards, outlet pipe, etc.)

### Final Check:

1. Record supporting data in accordance with the General Manual (Title 450, Part 407).

2. Plot 'As-built' in red on plans, sign and date. Plot the finished locations on the plan view. Note size and grade of all pipes.

3. Mark the Conservation Planning Map

4. Check off Practice on Conservation Plan and date completion.

5. Record in CON-6 Notes.

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## **UNDERGROUND OUTLET** (Code 620)

**Purpose**: To dispose of excess water from terraces, diversions or other concentrations without causing damage by erosion or flooding.

### Information Required:

1. Drainage area, in acres, using USGS maps, aerial photographs or field observations.

2. Runoff Curve Number (RCN).

3. Rainfall amount from the 10-year, 24-hour rainfall (10 $P_{24}$) in total inches and peak runoff.

4. Survey centerline of outlet to determine length and grades.

### Design Procedure:

Forms available: VT-ENG-1
VT-ENG-15
VT-ENG-20

1. Tabulate Time (hours) vs. ($Px/P_{24}$) on Form VT-ENG-20 (EFH, Chapter 2, Exhibit VT 2-4, Table 1). Px = ($Px /P_{24}$)*($P_{24}$) (Px in inches of runoff).

3. Size a conduit for the outlet and determine the release rate in cubic feet per second (cfs). EFH, Chapter 14, Exhibits 14-11.1, 14-11.2 and 14-11.3 pages 14-108.1 through 14-108.3. Convert to inches/hour using the following equation: in/hr = release rate (cfs)/drainage area (acres).

4. Calculate the accumulated outflow ($Q_0$) for each time coordinate starting at 12.5 hours (one hour after the beginning of the most intense portion of the Type II storm).

5. Calculate the volume of storage ($V_{s)}$ for each time coordinate by subtracting $Q_0$ from Qx . The maximum storage volume calculated is the required storage volume (ac-in) for the diversion.

6. Calculate the available storage in the diversion using the ‘average end area’ method. Since most diversions are parabolic in shape use the equation: Area (sq. ft.)=0.67 x T (top width) x d (depth).

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## UNDERGROUND OUTLET (Continued)

7. Compare the required storage to the available storage. Increase or decrease the size of the diversion as necessary until the required storage and available storage are equal.

8. If the resulting diversion is too large to be practicable, select a larger conduit size and repeat steps 4 through 9 until a reasonable combination of diversion size and conduit size is achieved.

9. Pressure flow may develop in the outlet conduit when there are several diversions discharging into the same underground outlet or the lower end of the conduit is on a much flatter grade than the upper end. This may cause water to flow out of the lower intakes rather than into them and may cause damage to the conduit itself. An orifice plate must be installed at the base of each riser to restrict the flow into the conduit and prevent pressure flow from developing. Use the procedure in the EFH, Chapter 8, pages 8-70 and 8-71 and Exhibit 8-5, page 8-102 to determine the size of the orifice plate that is needed.

10. Prepare construction drawings. Include the plan view, profile, design data, construction notes, soil boring logs and estimated quantities. Also, include detailed drawings of appurtenances such as the perforated riser, orifice plate, headwall and small animal guard.

11. Prepare; bill of materials, assemble appropriate construction and material specifications.

12. Check for location of public and private utilities in accordance with Part 503 of the National Engineering Manual. Place caution statement on drawings.

### Construction Layout:

1. Locate and stake perforated riser and other system components.

2. Set grade and alignment stakes for the outlet conduit.

3. Coordinate all staking with the contractor and landowner to assure efficient use of staff time.

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## UNDERGROUND OUTLET (Continued)

### Construction Inspection:

1. Landowner/operator, the contractor or his/her representative and the NRCS person(s) responsible for providing assistance during construction. Review the role of each of the parties involved in constructing the practice (see Misc.-A of Construction and Material Specifications for Conservation Practices). Review the drawings and specifications on the site and be certain there is a good understanding of them by the landowner and contractor. Be sure the landowner knows of construction elements critical to having NRCS on site concurrence.

2. Visit the site regularly during construction. Maintain a record of dates and times of visits, observations or problems, workmanship, progress, instructions and advice given and received and any other information bearing on the quality or efficiency of construction. Record in Job Diary or SCS-CON-6.

3. Check the elevations and grades of the outlet conduit. Make sufficient progress checks to prevent gross errors.

4. Check method of bedding, blinding and back-filling.

5. Check installation of riser, orifice plate, small animal guard and other appurtenances for location, materials and other important factors.

### Final Check:

1. Record the as-built geology of the completed underground outlet. Classify the materials to the full depth of the trench in several locations along its entire length using the Unified Soil Classification System. Indicate soil boundaries where classification changes occur. Record to scale on the plan and profile views of the construction drawings in red pencil or ink and note as "as-built".

2. Record supporting data in accordance with the General Manual (Title 450, Part 407).

2. Plot ‘As-built’ in red on plans, sign and date. Plot finished locations on plan view and plot profile. Note grade and pipe sizes, top of riser and invert.

4. Mark the Conservation Planning Map

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## **CULVERTS** (EFH CHAPTER3)

**Purpose:** To convey water from an intermittent source without causing damage by erosion or flooding.

### Information Required:

1. Drainage area, in acres, using USGS maps, aerial photographs or field observations.

2. Runoff Curve Number (RCN).

3. Rainfall amount from the 10 year, 24 hours rainfall ($10P_{24}$).

4. Survey area to determine length and grade.

5. Adequacy of outlet

6. Design discharge

### Design Procedure:
(EFH Pages 3-30 through 3-37)

Forms available: VT-ENG-1 Time of Concentration and Peak Discharge
VT-ENG-15 Runoff Curve Number

1. Plot profile to determine grades.

2. Establish the culvert invert elevations at inlet and outlet and the culvert length. Determine the invert slope So (ΔElev./length) and compute L/(100*So).

3. Determine allowable headwater as measured from the culvert invert to the top of the headwater pool.

4. Compute the depth of flow in the stream channel (including flood plain) for the design flow and determine 'tail water' (TW) depth.

5. If there will be insignificant tail-water, assume inlet control.

6. Start with trial pipe size (Q/10). Trial and Error to design pipe size. Use Exhibit s 3-9 and 3-10, EFH, Page 3-91 and 3-92.

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## **CULVERTS** (Continued)

7. Check for inlet control. So>Sn.
   Where:
   So= design slope of culvert

   Sn = neutral slope – that slope of which the loss of head due to friction is equal to the gain in head due to elevation

8. Use Exhibit 3-5 on pages 3-76 through 3-81 of the EFH to determine the 'friction' slope. If the friction slope is less then the design slope then inlet controls. Other wise:

9. Using Exhibits 3-11 or 3-12, EFH, pages 3-93 & 3-94, connect design discharge with allowable head. Where this line crosses the turning line draw a straight line from there to the length of the culvert in feet and the proper entrance loss coefficient. Extend the line to the diameter scale.

### Construction Layout:

1. Stake inlet and outlet locations and grade.

2. Provide copies of plans and specifications to landowner.

### Construction Inspection:

1. Check construction to insure compliance with design grades and pipe size and kind.

2. Check for proper bedding material and compaction.

3. Check for stable outlet.

### Final Check:

1. Record supporting date in accordance with the General Manual.

2. Plot "As-built" in red on plans, sign and date. Plot location on plan and profile, lable finished elevations on profile.

3. Mark the Conservation Planning Map.

4. Check off Practice on Conservation Plan and date completion.

5. Record on CON-6 Notes.

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## HEAVY USE AREA PROTECTION (CODE 561)

**Purpose** - Properly manage runoff from barnyards for the protection of water quality and waste utilization.

### Information Required:

1. Sketch showing the barnyard area, all drainage areas contributing to runoff across the barnyard and the drainage path to, and location of, receiving watercourses.

2. A 'to scale' plan view of the barnyard area including adjoining areas where water management is needed as part of the overall design (e.g., barn roofs, uphill drainage requiring diversion, downstream area needed for filter strip or holding pond.)

3. As a minimum, one plotted profile and one plotted cross-section of the slab area referenced to the existing building(s).

4. Sufficient soils investigation to classify the soils of the area.

5. Herd size, average weight and frequency of use of barnyard.

### Design Procedure:

Forms available: VT-ENG-1 - Time of Concentration and Peak Discharge
VT-ENG-15- Runoff Curve Number
VT-ENG-13- Diversion-Waterway Design
VT-ENG-4 - Gutter Selection Size

1. Provide components for diverting all clean water from the barnyard area. Use form VT-ENG-13, Diversion/Waterway Design, show calculations for Roof Runoff Management in accordance with Standard 558, and use Form VT-ENG-4, Gutter Selection Size. Provide for culverts at drainage crossings. Line channels as needed to provide stability. Use Exhibit 7-6, page 7-48 EFH to design lining.

2. Calculate size of barnyard to be treated (consult Standard 561, Heavy Use Area Protection), (35 to 50 SF per animal unit). Plot plan view, profile(s) and cross-section(s). Show earth excavation and fill required for finished grade (A spreadsheet has been developed to design barnyards).

3. Show typical cross-section of concrete or asphalt paving, detail steel reinforcement, base course material, subsurface drainage, geotextile and curb details.

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## HEAVY USE AREA PROTECTION (continued)

4. Plot location of fence(s), entrance(s), curbing, roof gutters, gate(s), etc., on plan view and specify type. Refer to Practice Standard 382-Fence and fence specifications.

5. Show filter strip (refer to Practice Standard 393A-Filter Strip) or holding pond (refer to Practice Standard 313-Waste Storage Facility) as required.

6. Prepare bill of materials.

7. Assemble specification package.

### Construction Layout:

1. Stake out clean water diversions, flag roof gutters, downspouts, etc.

2. Stake corners of area to be treated, and locations of push-off ramps, gates, etc.

3. Stake holding ponds and/or filter strips to be installed.

### Construction Inspection:

1. Check diversion grades and cross-section, pipe sizes and locations, roof gutters, etc.

2. Check paving area

   a. Subgrade
      -Compaction/consolidation
      -Cleared and grubbed as necessary

   b. Wearing Course
      1. Concrete
         - Delivery slip showing correct mix
         - Slump, within tolerance
         - Placement and reinforcement
         - Expansion joints
         -Curing

      2. Asphalt
         -Air temperature > 50°F
         -Dry subbase
         -Delivery slips
         -Roller compaction of black top

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## HEAVY USE AREA PROTECTION (continued)

3. Finished grading.

4. Fencing.

5. Seeding and mulching refer to Practice Standard 342-Critical Site Planting.

**Final Check:**

1. Record supporting data in accordance with the General Manual (Title 450, Part 407).

2. Plot 'As-built' in red on plans, sign and date. On the plan view, label 'spot elevations', plot finished elevations on any cross-sections, note thickness placed of each material, height of curbs and location of weep holes.

3. Mark the Conservation Planning Map

4. Check off Practice on Conservation Plan and date completion.

5. Record in CON-6 Notes.

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## ROOF RUNOFF MANAGEMENT

(Code 558, AWMFH, Chapter 10, and EFH Chapter 6)

**Purpose**: To match roof area to roof gutter size and select the size and spacing of downspouts.

### Information Required:

**Information required for all procedures:**

1. Horizontal projection of roof area in square feet.

2. Design rainfall (10yr. 5 min. or 25 yr., 5 min.). Refer to Practice Standard Roof Runoff Management (558).

### FRENCH DRAIN DESIGN PROCEDURE

1. From site sketch or plans, compute the projected roof area contributing to the proposed drain.

2. Select the five-minute rainfall ($P_{5min}$) from Figure 1 or 2 on page VT558-2 of Practice Standard 558 - Roof Runoff Management. If protecting a barnyard, waste storage facility or other high hazard site, use the 25-year storm frequency.

3. For each reach, compute the roof runoff in cfs.

$$Q = \frac{A_{roof} * P_{5min}}{3600}$$

4. Select size of perforated corrugated plastic tubing using Exhibit 8-6 in Chapter 8 of the EFH page 8-103, or select size of perforated smooth interior plastic pipe using Exhibit 8-4 EFH page 8-101.

### Design Procedure Gutter Size Selection

(VT-ENG-4)

1. Sketch plan view showing dimensions of all roof areas where gutters are to be installed.

2. Calculate projected roof areas.

4. Assume gutter size and material.

5. Determine the roof area that can be drained when capacity is controlled by downspout capacity. See AWMFH, Amend VT-3, Figure 1, page 10-2.3.

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## ROOF RUNOFF MANAGEMENT (Continued)

6. Determine the roof area that can be drained when capacity is controlled by channel capacity. See AWMFH, Amend VT-3, Figure 2, page 10-2.4.

7. Divide the total roof area for the gutter being designed by the smaller of 5 or 6. The result, when rounded up to the next whole number, is the number of downspouts required.

8. Divide the eave length by the number of downspouts required to determine the spacing.

9. Complete Form VT-ENG-4.

10. Repeat for all other gutter locations being considered. One VT-ENG-4 form may be used for several trials and/or designs.

11. Check for location of public or private utilities in accordance with Part 503 of the National Engineering Manual. Locate and describe on construction drawings.

### Construction Layout:

1. Set and mark grades (The design gutter slope is 1/16 inch per foot (s = 0.00508 ft/ft)).

2. Mark location of gutter supports. The maximum spacing for galvanized steel shall be 48 inches. The maximum spacing for aluminum and plastic shall be 32 inches. Wood gutters shall be mounted on fascia boards using furring blocks a maximum of 24 inches part.

3. Mark location of downspouts.

4. Locate and flag or otherwise mark outlet.

5. Provide plans and specifications, etc., to landowner/user.

### Construction Inspection:

1. Check to insure compliance with design grades and sections.

2. Make certain that downspouts are securely fastened at the top and bottom. Intermediate supports may be needed when downspouts exceed 10 feet in height.

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## ROOF RUNOFF MANAGEMENT (Continued)

3. Check installation of special details (i.e., breathers, outlet pipes, rodent guards, etc.).

4. Make certain that roof runoff management facilities are protected from damage by livestock and equipment.

### Final Check:

1. Record supporting data in accordance with the General Manual (Title 450, Part 407).

2. Plot 'As-built' in red on plans, sign and date. Plot pipe locations, sizes and slopes on the plans and profile.

3. Mark the Conservation Planning Map

4. Check off Practice on Conservation Plan and date completion.

5. Record in CON-6 Notes.

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## VEGETATED FILTER AREA (Code 393)

**Purpose** - to remove sediment, organic matter and other pollutants from concentrated livestock area runoff and agricultural wastewater.

### Information Required:

1. A sketch showing the general area including such things a the source of the pollution, farm lanes, power lines, water courses or other features that may impact the design.

2. A survey to show the topography, source of waste and other pertinent physical features. Include enough area to show needed surface water diversions and subsurface drain outlets.

3. Plot at least one profile and one cross-section of the area where the vegetated filter area is to be constructed. Additional cross sections may be needed if considerable earthwork is anticipated. The profile should include the entire flow path of the runoff or wastewater from the source to the vegetated filter area.

4. Soil borings to determine soil types, depth to water table and depth to bedrock.

5. Size of barnyard for concentrated livestock areas or:

6. Determine the weekly volume of runoff or wastewater to be treated. For milk house wastewater flows must be less than 500 GPD.

### FILTER STRIP DESIGN PROCEDURE FOR BARNYARD RUNOFF

1. Determine the largest long-term average monthly precipitation from appendices 10-B and 10-C of the AWMFH.

2. Convert the monthly precipitation to runoff using the procedure beginning on page 1OC-1 in Chapter 10 of the Agricultural Waste Management Field Handbook.

3. Calculate the normal weekly runoff by dividing the monthly runoff calculated in step 3 by 4 (weeks per month).

6. Compute the runoff from the barnyard in cfs (Runoff in cfs/acre x size of barnyard in square feet / 43,560).

7. Compute volume of settling area or basin in cubic feet (Barnyard runoff in cfs x 15 Minutes x 60 Seconds).

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## VEGETATED FILTER AREA (Continued)

8. Determine dimensions of settling basin. Dimensions should include a ramp to allow for access to clean it out. On-lot storage can be considered.

9. Add freeboard to depth of settling basin.
   a. Basin Cleaned Regularly - Add 0.5”
   b. Basin Cleaned Rarely - Add 6.0”

10. Determine the flow length.

11. Compute the velocity of flow through the filter strip (Velocity = Flow Length *15 Min.* 60 Sec./Min.)

12. Compute the cross sectional area of flow through the filter strip. Area = Flow (cfs) / Velocity (fps)

13. Compute the minimum filter strip width when the flow depth is 0.5 inches (or less). Width = Area ($FT^2$) x 12 inch/foot 0.5 inches.

## FILTER STRIP DESIGN PROCEDURE FOR MILKHOUSE WASTE

DESIGN PROCEDURE:

1. Calculate the Volume of waste produced.

2. Provisions for settling solids must be provided. The settling basin may be a part of the contributing area or a separate area by itself. The minimum storage volume for the settling area, in (CF), shall be determined by multiplying the peak rate of inflow (Q) from the 2-year, 24-hour storm (CFS), by 900 seconds (15 minutes x 60 seconds per minute). The settling area shall have a restricted outlet to allow time for the solids to settle. Two 3/4" slots or one 4” diameter hole through the curb or wall will suffice in most cases. It could be a septic tank.

3. Size Dosing Tank (Daily Production x 3 Days).

4. Compute the weekly production of waste in cubic feet (Daily Production x 7 Days * 7.48 Gallons / $FT^3$).

5. Compute the filter strip area needed (Weekly Volume (CF) x 12 inches/foot/1 inch).

6. Determine the minimum flow length.

7. Compute width of filter strip (Area ($FT^2$)/Minimum Flow Length (FT)).

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## VEGETATED FILTER AREA (Continued)

8. The flow must be distributed uniformly across the top of the filter area. A trench 18 inches wide and 4 feet deep filled with 3/4" to 1.5" stone across the entire width of the filter area is a good means of establishing sheet flow. The stone needs to be mounded about 6 inches along the edge closest to the filter area to allow for better distribution of the flow through the stone.

9. Prepare construction drawings. Include the plan view, a profile and one or more cross sections, design data, soil boring logs and estimated quantities. Also include detailed drawings or appurtenances such as settling basins, grease traps, transfer pipe, dosing system and clean water diversions.

10. Prepare a bill of materials.

11. Assemble appropriate construction and material specifications.

12. Check for the location of public and private utilities in accordance with Part 503 of the National Engineering Manual. Include a caution statement on the drawings.

### Construction Layout:

1. Locate and stake the filter area, stone trench, diversions, wastewater transfer lines and other system components.

2. Set cut stakes with cuts marked for required excavations.

3. Set grade and alignment stakes for the transfer pipe, grease trap and other appurtenances.

4. Coordinate all staking wit the contractor and landowner/ operator to assure efficient use of manpower.

### Construction Inspection:

1. Arrange for a pre-construction conference. Those present should include the landowner/operator, the contractor of his/her representative and the NRCS person(s) responsible for providing assistance during construction. Review the role of providing assistance during construction. Review the role of each of the parties involved in constructing the practice (see Misc.-A of the Construction and Material Specifications for Conservation Practices). Review the drawings and specifications on the site and be certain that there is a good understanding of them by the landowner/operator and contractor. Be sure the landowner/operator knows of the construction elements critical to having NRCS on site concurrence.

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## VEGETATED FILTER AREA (Continued)

2. Check site preparation, including stripping of topsoil and removal of obstructions and debris.

3. Visit the site regularly during construction. Maintain a record of dates and times of visits, observations of problems, workmanship, progress, instructions and advice given and received and any other information bearing on the quality or efficiency of construction. Record in Job Diary or SCS-CPA-6.

4. Inspect the materials in any excavations to assure they are consistent with those shown on the design. If they are different, consult the designer for acceptability or design changes.

5. Check for unforeseen ground water seepage. Consult with the designer for adjustments to the design, as necessary.

6. Make certain that the vegetated filter area is level from side to side; and, has the appropriate slope form top to bottom.

7. Check the installation of the stone filled trench making sure that the stone along the edge nearest the filter area is at least 6 inches higher than the rest of the trench.

8. Check the installation of the settling tank and/or grease trap, transfer pipe and other appurtenances for location, grade, materials and other important factors.

9. Check the finished elevations and dimensions. Make sufficient progress checks to prevent gross errors.

10. Check installation of drainage systems, diversions, fencing, seeding, access roads and other component practices.

**Make certain that the landowner/operator understands that the filter area must not be used until the vegetation has become established. The wastewater needs to be diverted throughout the establishment period.**

### Final Check:

1. Record supporting data in accordance with the General Manual (Title 450, Part 407). Record the as-built geology of the completed vegetated filter area. Classify the soil materials from 0-2 feet of depth at the four corners and center of the filter area using the Unified Soil Classification System. Map soil boundaries where classification changes occur.

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## VEGITATED FILTER AREA (Continued)

2. Record on the plan and section views of the construction drawings in red pencil or ink and note as "as-built".

3. Plot ‘As-built’ in red on plans, sign and date. Plot cross sections corresponding to design cross-sections and label spot elevations on plan view.

4. Mark the Conservation Planning Map

5. Check off Practice on Conservation Plan and date completion.

6. Record in CON-6 Notes.

**NATURAL RESOURCES CONSERVATION SERVICE-VERMONT**

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## WASTE STORAGE FACILITY

Minimum Design Content

### Drawings

1. Plan View:

   a. Existing topography, significant trees, utilities, buildings, fences, pipes, tile, unusual boulders and obstructions, other significant features, stream configuration including direction of flow.

   b. Toe and top of embankments.

   c. Benchmark location and description and north arrow.
   d. Access route to site.

   e. Location of soil borings taken (minimum of two).

   f. Bar scale and north arrow.

   9. Boundary of area to be vegetated.

   h. Location of any filter strips and/or tree and shrub plantings.

   i. Other appurtenances; barnyards, diversions, etc.

2. Profile:

   a. Profile shall include:

   - Top of constructed and settled embankment

   - Soil borings

   - Ground water levels at date of survey

   - Bed rock:

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## WASTE STORAGE FACILITY

Minimum Design Content

3. Cross Sections:

    a. Minimum of two cross sections to depict representative cuts and fills required.

    b. Show embankment section and finished fill surface above existing ground, tile, vegetation limits, etc.

4. Miscellaneous Details:

    a. Manure Hopper, transfer pipe, concrete thickness, location of agitating pads, re-bar spacing, wall thickness, manure pump location, tile outlet rodent guard, etc.

    b. Other details as may be required to convey special features to the installer.

    c. Vicinity map showing site location.

5. Construction Notes:

    a. Specify compaction effort.

    b. Note that construction inspection shall be carried out as per the inspection plan if a formal contract or according to this guide for all other conservation practices.

    c. Specify the gravel (drainfill) gradation..

    d. List the required construction, material specifications by number and list the estimated quantity for each.

6. Other:

    a. Identify engineering job class above title block.

    b. List dates of any revisions after initial delivery to landowner.

    c. Complete title block: - Practice - Landowner - Town, State - Identify designer, checker, etc.

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## WASTE STORAGE FACILITY

Minimum Design Content

### Specifications:

1. Complete "Construction and Material Specifications Table of Contents" (Form Misc.-B).

2. Include "General Requirements" (Form Misc.-A).

3. Include all construction and material specifications checked on table of contents (Form Misc.-B).

4. Special notes for specifications:

| Specification Number | Specification Name | Notes: |
|---|---|---|
| 1 | **Site Preparation** | Specify depth of stripping and designate a disposal area, may be on outside of embankment |
| 11 | **Earthwork** | -Specify what kind **excavation** (common, rock or uncommon) and designate borrow area. -For **trenches** show bottom width, side slopes and application of grade line (particle size less than 3" within 2' of pipe. |
| | Earthfill | -Specify maximum particle size, choose compaction: class A; >95% standard Proctor; Class B: Density as specified on plans; Class C: specified number of passes of machinery. |
| | Drainfill (Gravel) | -Specify consolidation: Class A: 70% relative density; Class I: 2 passes of a vibratory roller; Class IIa: 2 passes of a 75 psi roller; Class IIb: 4 passes with a crawler tractor, minimum weight of 20 tons; Class IIc: traveled over by hauling equipment; Class III: no extra effort other than placing. Specify gradation of Drainfill and aggregates. |
| 52 | Seeding | Specify 7A, 7B, 7C and drainage class |

### Cover Sheet

1. Prepare cover sheet for design listing number of drawing sheets (Form VT-ENG-3).

**NATURAL RESOURCES CONSERVATION SERVICE-VERMONT**

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## WASTE STORAGE FACILITY

Minimum Design Content

### Design Computations and Back Up:

1. The cooperator's folder will contain:

   a. The completed design.

   b. All data gathered to develop the design; soils, survey notes, herd numbers, etc.

   c. Design analyses:
   - Environmental considerations
   - Hydrology
   - Hydraulics
   - Filters or bedding
   - Other

   d. Bid Schedule (if formal contract)

   e. Construction performance time estimate (if formal contract)

   f. Inspection plan (if formal contract).

   g. Quantity computations

   h. Operation and Maintenance Plan.

### Final Check:

1. Record supporting data in accordance with the General Manual (Title 450, Part 407).

2. Plot 'As-builts' in red on plans, sign and date. Plot all profiles and cross-sections on design cross-sections, plot locations of spot elevations and measured dimensions and any variation to the soils encountered from the test pits.

3. Mark the Conservation Planning Map

4. Check off Practice on Conservation Plan and date completion.

5. Record in CON-6 Notes.

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## **WASTE STORAGE POND** (Code 313, AWMFH)

**Purpose** - To provide temporary storage for liquid and solid waste, wastewater, and polluted runoff to reduce pollution.

### Information Required:

1. Determine the source, quantity and condition of waste to be stored. Record the herd size, include all livestock, average weight of each type of livestock, Average Annual Herd Production, bedding system, silage leachate, and disposition of wash water.

2. Establish the storage period from the Nutrient Management Plan and record. The minimum storage period is 90 days, consider a full year's storage.

3. Select a system type (solid, semi-solid, liquid) compatible with equipment, bedding system, structural features and the cooperator's desires.

4. Select and plan a suitable location to provide feasible loading and unloading systems. Give consideration to existing buildings, future expansion, access routes, traffic patterns, drainage, utilities, equipment capabilities, possible odor problems and appearances.

5. Determine if the site(s) is in an aquifer protection area and the location of the site(s) relative to existing or planned wells and springs, refer to Section I, Maps in the Vermont Field Office Technical Guide.

6. Excavate and log test pits for the foundation evaluation. Check for signs of poor stability, embankment suitability, excessive leakage, bedrock and high water table (Record on SCS-538 or equiv.). Obtain samples for laboratory analysis as necessary to evaluate soil for sealing against seepage losses. Classify the soils using the Unified Soil Classification System procedure (see Chapter 4 of the Engineering Field Handbook).

7. Survey and prepare a topographic map of the site, including buildings, utilities, access routes and test pit locations. Include town and other zoning setbacks, right of ways, property lines, easements and other features having a bearing on the pond location.

### Design Procedures:

Forms Available: Worksheet 10A-1 Waste Storage Structure Capacity Design, AWMFH
Worksheet 10A-2 Waste Storage Pond Design AWMFH, Chap. 10 Appendix.
SCS-ENG-342 Earth Fill Computations
VT-AWMFH Chapter 10, page 10D-6. Flow Chart.

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## WASTE STORAGE POND (Continued)

1. Avoid the installation of waste storage ponds in sandy or gravelly soils (USCS: SP, SP-SM, SW, GP, GP-GM, GW) or directly over bedrock. Consider alternate sites, aboveground storage or an approved liner if in-ground storage is the only option.

2. Other soil materials, not included in #1 above, and not involving bedrock, may be suitable in-place or reworked based on the potential of the site to impair ground water, or surface water use, or cause a threat to live-stock and human health.

3. Determine if ground water tables can be controlled to accommodate the storage pond. Design appropriate drainage features. Drainage to control groundwater will be place outside of the centerline of the top of the storage.

4. Determine the required waste storage volume.

5. Establish the preliminary layout, including side slopes and the top of the dike. Design depths greater than ten feet should be avoided.

6. Determine the drainage area contributing direct precipitation to the storage. Use the centerline of the dike as the drainage area boundary. Divert clean surface water around the site and dispose of in a non-erosive manner.

7. Compute the required precipitation storage for the contributing area.

8. Compute the required storage for accumulated solids. Use a minimum of six inches of depth over the bottom of the holding pond.

9. Determine the total required storage (Design depth minus ( direct precipitation – evaporation + 25 yr. 24 hr. storm + solids accumulation + freeboard + runoff).

10. Determine the available storage. For irregular shapes, use the standard procedures for stage-storage relationships. For regular shapes, use the following formulae:
Square or rectangle: $V=XYD+(X+Y)*ZD^2+4/3Z^2D^3$
Circular: $V=\Pi/4(W2D+2ZWD^2+4/3Z^2D^3)$

    Racetrack: $V=\Pi/4(W^2D+2ZWD^2+4/3Z^2D^3)+WDL+ZD^2L$

    Where: X = Length at the bottom
    Y = Width at the bottom
    D = Available Depth
    Z = Inside Side Slope
    W = Diameter of pond at bottom
    L = Straight length of racetrack at bottom

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## WASTE STORAGE POND (Continued)

11. Compare the available storage with the required storage. Adjust the layout and repeat computations until the required and available storage are equal. Electronic spreadsheets are available for designing Waste Storage Ponds.

12. Select elevations and compute cuts and fills. Adjust elevations within the limits of topography and other considerations until a reasonable balance, considering appropriate balance factor, is obtained. Increase constructed fills height by 10% to allow for settlement. Calculate earth fill volume from TSC-NE-ENG-1114, EFH, pages 11-56.1 through 11-56.5.

13. Where cut and fill balance cannot be achieved, designate borrow areas or waste area.

14. Review the design with the owner. Include a discussion of required and optional appurtenances such as ramps, docks, diversions, picket dams and vegetate screening.

15. Prepare final drawings. Include the plan view, one or more cross-sections, profile along centerline of fill, design data, construction notes, test pit logs and estimated quantities. Also, include detailed drawings of appurtenances such as picket dams, concrete floors and ramps, transfer pipe, concrete, timber or concrete block hoppers and concrete headwalls. Drawing quality must be adequate to produce usable blue or black-line copies.

16. Check for location of public and private utilities in accordance with Part 503 of the National Engineering Manual. Place caution statement on drawings.

17. Attach appropriate construction specifications to drawings.

### Construction Layout:

1. Locate and stake diversions, tile lines, manure delivery lines or other appurtenances.

2. Set toe stakes for dikes and embankments. Mark required fill heights with consideration for a minimum of 10% over-fill.

3. Set top of cut stakes with cuts marked for required excavations.

4. As earthwork progresses, set slope stakes as necessary to assure construction to line and grade.

5. Set grades for top of embankment and bottom of excavation for finish grading.

6. Set grade and alignment stakes for concrete floors, picket dams and other structural features.

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## WASTE STORAGE POND (Continued)

7. Coordinate all staking with the contractor and the owner to assure efficient use of limited staff.

### Construction Inspection:

1. Arrange for pre-construction conference with the landowner to include the landowner, the contractor's representative at the site during construction and the NRCS person(s) responsible for providing assistance during construction. Review the role of the landowner, the contractor and NRCS for constructing the practice. (See Misc.-A of "Construction and Material Specifications for Conservation Practices"). Review the drawings and specifications with them on the site and be sure there is a good understanding of them by the landowner and contractor. Be sure the landowner knows of construction elements critical to having NRCS on site concurrence.

   Visit the site regularly during construction. Maintain a record of dates and times of visits; observations of problems, workmanship and progress; instructions and advice given and received; and any other information bearing on the quality or efficiency of construction (Job Diary or SCS CONS-6). If a job diary is used put copies in the cooperator's folder.

2. Carefully inspect materials in the cuts and fills to assure they conform to those shown on the design. If they are different, consult the designer for acceptability or design changes.

3. Check for unforeseen ground water seepage. Consult with designer for adjustments to design as necessary.

4. Check the finished elevations, dimensions and side slopes, embankments and excavations. Make sufficient progress checks to prevent gross errors.

5. Check site preparation, including stripping of topsoil and removal of structures or debris.

6. Periodically observe fill material, moisture content and compaction procedures to assure adequate embankment construction. Check proper application of topsoil to embankments.

7. Check concrete installation including; grades, forms, steel, construction joints, mix design, placing, consolidation, and curing. Perform slump tests and air entrainment tests of concrete as necessary.

8. Check timber installation including species, grade, size, treatment of timbers, quality of hardware, alignment and embedment of posts and proper connections.

9. Check installation of drainage systems, diversions, seeding, fencing, access roads and other component practices.

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## WASTE STORAGE POND (Continued)

### Final Check:

1. Record supporting data in accordance with the General Manual (Title 450, Part 407).

2. Record as-built geology of the completed facility. Classify the soil material from 0’ to 2’ of depth at important locations in the excavated portion of the pond. For rectangular shapes, show the center and the four corners of the bottom, and selected points on the slope. For round or irregular shapes, show the center and at least four toe points in the bottom. Map soil boundaries where classification changes occur. Record to scale on the plan view drawing of the facility in red pencil or ink and note as "as-built".

3. Plot ‘As-built’ in red on plans, sign and date. Plot all profiles and cross-sections on design cross-sections, plot locations of spot elevations and measured dimensions and any variation to the soils encountered from the test pits.

4. Mark the Conservation Planning Map

5. Check off Practice on Conservation Plan and date completion.

6. Record in CON-6 Notes.

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## WASTE STORAGE STRUCTURE (Code 313)

**Purpose** - To provide temporary storage for liquid or solid wastes as part of a pollution control or energy utilization system to conserve nutrients and energy.

### Information Required:

1. Determine the source, quantity and condition of the waste to be stored. Record herd size, average weight, bedding system and disposition of wash water. Form VT-PDM-L is useful for this purpose.

2. Establish a storage period from unloading and spreading schedule and record. The minimum storage period is 90 days. Watershed plans provide storage periods for projects. Vermont's Department of Agriculture has rules banning spreading during the winter.

3. Select a system type (solid, semi-solid, liquid) to be compatible with equipment, bedding system, structural features **and the owner's desires.** Remember, in Watershed Projects, the least cost reasonable alternative becomes the basis for cost sharing.

4. Select and plan a suitable location to provide for feasible loading and unloading systems. Give consideration to existing buildings, future expansion, access routes, traffic patterns, drainage, utilities, equipment capabilities, possible odor problems and appearances. Conform to local ordinance, health department and milk inspection requirements.

5. Excavate and log test pits for foundation evaluation. Check for signs of low bearing strength, drainage or leakage problems and existence of bedrock or large boulders. (Record on SCS-538 or equivalent) Show logs on drawings.

6. Survey and prepare a topographic map for site-specific designs.

### Design Procedures:

### Commercial Designs (Slurrystore, Agway, etc.)

1. Determine the required storage volume for the desired storage period. Include six inches for accumulated solids. For structures without roofs, include as direct precipitation and the normal rainfall minus evaporation for the storage period. Consider that if the pit is only used part of the year, if it is only emptied once then the total years rainfall will be included in the volume calculations

2. Compare the required storage with available storage provided in the proposed design. Balance.

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## WASTE STORAGE STRUCTURE (Continued)

3. Evaluate foundation against excessive or differential settlement, sliding, inadequate drainage and flotation, as applicable.

4. Be sure the selected design has NRCS approval prior to installation.

5. Prepare an overall design that includes the pre-approved non-SCS structure as a component. Identify the appropriate non-SCS pre-approved drawing number on the NRCS overall design. Obtain proper design pre-approval (pre-approved drawing approval does not constitute overall design approval).

### Service Designs:

1. Determine the required storage volume as in Commercial Designs.

2. Select structure dimensions to provide adequate storage. Roofed structures are best limited to 40 feet in width for practical truss design. Structures without roofs are most economical when length and width are approximately equal.

3. Show the location on a topographic map. Include the location of the loading system, agitation and pumping points, gates, access routes and other pertinent data.

4. Determine the basic construction material. Timber, reinforced concrete and pre-cast concrete are the usual choices.

5. Evaluate foundation against excessive or differential settlement, sliding, inadequate drainage and flotation, as applicable.

6. Review the preliminary design with the owner. Discuss required and optional appurtenances such as ramps, diversions, picket dams, and vegetative screening, etc.

7. Prepare final drawings. Include the plan view, one or more cross-sections, design data, construction notes, test pit logs, and estimated quantities. Also, include detailed drawings of appurtenances such as picket dams, concrete floors and ramps, headwalls, retaining walls, etc. Drawing quality must be adequate to produce usable copies.

8. Check for location of public land private utilities in accordance with Part 503 of the National Engineering Manual.

9. Attach appropriate construction specifications to drawings.

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## WASTE STORAGE STRUCTURE (Continued)

### Construction Layout:

1. Set grade stakes with cuts marked for site preparation.

2. Set offset stakes with cuts for drainage lines, manure delivery lines or other appurtenances.

3. Set grade stakes appropriately marked for floor elevation.

4. Locate and stake the center, corners and/or wall alignment. Use offset stake as appropriate. Layout must be accurate and true. Use wood stakes with nails for alignment and control points. Measure all distances with a steel tape. For rectangular structures, measure diagonals to assure structure is square.

5. Coordinate all layout with the contractor and owner to be sure usable and timely layout is provided. This is especially important where qualified contractors provide some of the layout.

### Construction Inspection:

1. Check the finished elevations of subgrade, footers, floors, backfill and other important points.

2. Concrete Structures:

   a) Check the size, manufacturer, location, placement, spacing, splicing and other pertinent features of the reinforcing steel (grade 60 steel).

   b) Check the required excavations for adequate size and depth.

   c) Check the forms for proper size, support, tightness, strength and alignment.

   d) Check the concrete mix design for compliance with construction specifications. Obtain typical strength tests from the supplier if possible.

   e) Check the location of anchor bolts, construction joints, water stops and other imbedded items.

   f) Be sure adequate preparations are made for handling and placing concrete.

g) Check to assure that concrete is properly placed and consolidated.

h) Perform slump and air entrainment tests on representative samples of the concrete as necessary.

i) Check to be sure forms are properly removed, the concrete is properly cured and any defective concrete is properly repaired.

3. Timber Structures:

a) Check with the supplier to see that timbers are of proper grade, species and treatment.

b) Check that posts have the proper location, orientation, spacing, embedment and backfill.

c) Check that nails and bolts are of the specified quality and used in the specified quantity.

d) Check that concrete floors and ramps meet design requirements.

4. Check that backfill is properly compacted to the specified extent and grade.

5. Check that drainage systems and other appurtenances are properly installed.

6. For roofed structures, check that trusses are properly designed for snow loads.

7. Maintain a record of dates and times of visits to the site; observations of problems, workmanship and progress; instructions and advice given and received; and any other information bearing on the quality or efficiency of construction (Job Diary or SCS-CONS-6).

**Final Check:**

1. Record supporting data in accordance with the General Manual (Title 450, Part 407).

2. Record as-built geology of the completed facility. Classify the soil material from 0’ to 2’ of depth at important locations in the excavated portion of the pond. For rectangular shapes, show the center and the four corners of the bottom, and selected points on the slope. For round or irregular shapes, show the center and at least four toe points in the bottom. Map

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## WASTE STORAGE STRUCTURE (Continued)

soil boundaries where classification changes occur. Record to scale on the plan view drawing of the facility in red pencil or ink and note as "as-built".

3. Plot ‘As-built’ in red on plans, sign and date.

4. Mark the Conservation Planning Map

5. Check off Practice on Conservation Plan and date completion.

6. Record in CON-6 Notes.

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## WASTE TREATMENT LAGOON (Code 359)

**Purpose** - To biologically treat organic waste and reduce pollution.

### Information Required:

1. Determine the source, quantity and condition of the waste to be treated. Record the herd size (if applicable), type of milking system, number of cows milked, etc.

2. Select a suitable site giving proper consideration to location from barns, topography, existing watercourses, drainage, obvious soil limitations, water supply, utilities and aesthetics.

3. Determine if the site is in an aquifer protection area and the location of the site(s) relative to existing wells and springs.

4. Excavate and log tests pits for evidence of excessive leakage, high water table, proximity to bedrock and suitability for fill. Document logs. Obtain sample(s) for laboratory analyses as necessary to evaluate seepage losses in sensitive areas and soils.

5. Survey and prepare a topographic map of the site. Show property lines, barns, utilities, watercourses and other important features. Use two-foot contour intervals and a scale of one inch equals 40 feet or larger. Enter town or other zoning set backs, right-of-ways or other features having a bearing on the lagoon's location.

6. Select a suitable location for the settling tank.

### Design Procedures:

1. Avoid the installation of waste storage ponds in sandy or gravelly soils (USCS: SP, SP-SM, SW, GP, GP-GM, GW) or directly over bedrock. Consider alternate sites, aboveground storage or an approved liner if in-ground storage is the only option.

2. Other soil materials (not included in #1 above) and not involving bedrock may be suitable in-place or reworked based on the potential of the site to impair ground water, or surface water use, or cause a threat to livestock and human health.

    a. If a site is not located in a wellhead protection area and is more than 500 feet from a well or spring water supply a biological seal can be assumed.

    b. If a site is not located in a wellhead protection area and is located between 250 feet and 500 feet of a well or spring water supply and the SEEPAGE rating for the site is "moderate" or "low", a biological seal can be assumed.

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## WASTE TREATMENT LAGOON (Continued)

c. Other sites must be planned and designed considering the guidelines provided in Chapter 7 of the Agricultural Waste Management Field Handbook. Consult with the assisting engineer or geologist on the appropriate hydraulic conductivity to use in the analyses.

3. Determine if ground water tables can be controlled to accommodate the lagoon. Design appropriate drainage features as necessary. Drainage to control groundwater will be place outside of the centerline of the top of the storage.

4. Establish a minimum surface area and operating depths according to the herd size and engineering standards.

5. Establish a preliminary layout adhering to criteria in current standards for embankment heights, top widths and slopes, plan configuration, depths and bottom grades.

6. Determine the drainage area contributing direct precipitation to the lagoon. Use the centerline of the dike as the drainage area. Direct clean surface water around the site and dispose of in a non-erosive manner.

7. Compute cut and fill volumes. Adjust elevations until a reasonable balance of cut and fill is obtained. Where cut and fill cannot be balanced, designate borrow or waste areas.

8. Determine the size, location and elevation of the settling tank.

9. Determine the location, grade, elevation, size and material for the inlet line. Determine the pump type and size, if required.

10. Determine the type, size, location and design of the outlet structure.

11. Review the design with the owner. Include discussions of inlet and outlet works land any special features.

12. Prepare final drawings. Include the plan view, one or more cross-sections, pipelines profiles, design data, construction notes, test pit logs and estimated quantities.

13. Check for location of public and private utilities in accordance with Part 503 of the National Engineering Manual. Place caution statement on drawings.

14. Attach appropriate construction specifications to the drawings.

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## WASTE TREATMENT LAGOON (Continued

### Construction Layout:

1. Set top-of-cut stakes with cuts marked for required excavations, including cutoff trench.
2. Set toe stakes for dikes and embankments. Mark required fill heights with consideration for over-fill.
3. As earthwork progresses, set slope stakes as necessary to assure construction to line and grade.
4. Set stakes for alignment and grade of inlet and outlet works.
5. Set grades for top of embankment ad bottom of excavation for finish grading.
6. Locate and stake diversions, waterways, or other component practices.
7. Coordinate all staking with the contractor and the owner to assure efficient use of our staff.

### Construction Inspection:

1. Visit the site regularly during construction. Maintain a job diary narrating dates and times of visits; observations of problems, workmanship and progress, instructions and advice given and received and any other information bearing on the quality or efficiency of construction.
2. Carefully inspect materials in the cuts and fills to assure they conform to those shown on the design. If they are different, consult the designer for acceptability or design changes.
3. Check for groundwater seepage. Consult with designer for adjustments to design as necessary.
4. Check finished elevations, dimensions and side slopes of cutoff trench, embankments and excavations. Make sufficient progress checks to prevent gross errors.
5. Check site preparation, including stripping of topsoil and removal of structures or debris.
6. Observe cutoff trench excavation and determine final grades.
7. Periodically observe fill material, moisture content and compaction procedures to assure adequate embankment construction. Check proper application of topsoil to embankments.
8. Check installation of the settling tank, inlet and outlet works for location, grade, material, joint tightness and other important factors.

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## WASTE TREATMENT LAGOON (Continued)

9. Check installation of waterways, diversions, seeding, fencing and other component practices.

### Final Check:

1. Record supporting data in accordance with the General Manual (Title 450, Part 407).

2. Record as-built geology of the completed facility. Classify the soil material from 0’ to 2’ of depth at key locations in the excavated portion of the pond. For rectangular shapes show the center and the four corners of the bottom, and selected points on the slope. For round or irregular shapes show the center and at least four toe points in the bottom. Map soil boundaries where classification changes occur. Record to scale on the plan view drawing of the facility in red pencil or ink and note as "as-built".

3. Plot ‘As-builts’ in red on plans, sign and date.

4. Mark the Conservation Planning Map

5. Check off Practice on Conservation Plan and date completion.

6. Record in CON-6 Notes.

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## **STREAMBANK PROTECTION** (Code 580, EFH, Chapter 16)

**Purpose** - To stabilize and protect the banks of streams or excavated channels against scour and erosion, by structural and/or vegetative means.

### Information Required:

1. Drainage area, 2 year 24 hour rainfall, average snow fall, area of ponds and swamps.

2. Log soils data (SCS-ENG-538 or equivalent) of bank materials and proposed filter or bedding materials, if applicable. Use Unified Soil Classification System.

3. Topographic survey of stream-bank and adjoining area to develop a plan view. Locate a benchmark and other significant features such as shade trees, roads and buildings. Identify stable end points for stone center tiebacks.

4. Stream channel characteristics; i.e., slope of normal water line, cross-section, Mannings "n" value, ordinary high watermark and the other necessary data to complete forms VT-ENG-10 and VT-ENG-11.

5. Hazard Class.

6. Engineering Job Class.

### Design Procedures:

Forms available: VT-ENG-10
VT-ENG-11
VT-ENG-59A
VT-ENG-59B

1. Complete forms VT-ENG-10 and VT-ENG-11 in accordance with Exhibit 16-1, EFH, pages 16-21.1 through 16-21.14. If another design procedure is used, computations should be shown.

2. Select bedding method or design a filter if applicable. Refer to the Engineering Standard for ‘Stream-bank and Shoreline Protection’ (580), Vermont Supplement, Vermont Technical Guide for discussion and procedures.

3. Select the design storm from the table on page VT-580-3 in the Vermont Supplement. Calculate the discharge in cfs using the procedures in Flood Magnitude and Frequency of Vermont Streams by Carl G. Johnson and Gary D. Tasker, March 1974.

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## STREAMBANK PROTECTION (Continued)

4. Assume the top of the riprap to be 2 - 3 feet above ordinary high water and the remainder of the bank is stabilized by vegetation. Using Manning's equation, calculate the channel velocity in accordance with the criteria shown in the table on page VT-580-3 in the Vermont Supplement. If the velocity is less than 4 fps, this is a safe design. If the velocity is greater than 4 fps, the riprap must be extended to a height equal to the elevation of the design storm.

5. Prepare final drawings. Include the plan view (preferably to scale), one or more cross-sections, construction notes, location of tie-backs, test pit locations and logs, TBM location, north arrow, rock and bedding gradation in tabular form, rock quality, and estimated quantities. Note: for heights of riprap less than 5 feet, Form VT-ENG-59A or VTENG-59B may be used in lieu of plotted typical cross-sections. Typical cross-sections shall be provided on all jobs over 5 feet in height.

6. Complete "Construction and Material Specifications Table of Contents" (Form Misc-B). Assemble specifications making certain that Form Misc-A "General Requirements" is included.

7. The final design package should include quantity computations and other computation sheets that may have been used in the preparation of the design.

8. Check for location of public and private utilities in accordance with Part 503 of the National Engineering Manual. Locate and describe on construction drawings.

9. Ascertain that landowner has obtained all necessary permits; i.e., stream alteration and 404 if applicable.

### Construction Layout:

1. Set top-of-cut-stakes.

2. Locate key trench.

3. Set stakes for location of stone center tiebacks.

4. Identify dead and leaning trees and mark for removal.

5. As earthwork progresses, set slop stakes as necessary to assure construction to line and grade.

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## STREAMBANK PROTECTION (Continued)

### Construction Inspection:

1. Visit the site regularly during construction. Maintain the SCS-CPA-6 narrating dates and times of visits, observations of problems, workmanship and progress, instructions and advice given and received and any other information bearing on the quality or efficiency of construction.

2. Check site preparation, including earthwork, removal of dead and leaning trees, other debris, and depth of key trench.

3. Make certain that all trees, brush and other debris that is removed is properly disposed of in accordance with the specifications and local and state ordinances.

4. Check excavation for stone center tiebacks to make certain they are the prescribed dimensions.

5. Observe placement of filter or bedding material. Check thickness of blanket and gradation.

6. Observe placement of riprap. Make certain that rock is placed carefully so as not to damage filter of bedding blanket. Check the thickness of the riprap layer and the quality and gradation of the rock. Use the Williamson Unified Rock Classification System (TR-71) to check rock quality. Exhibit 16-1, EFH, pages 16-21.12 through 16-21.14 shall be used to check gradation.

7. Check and record finished elevations, dimensions and slopes.

### Final Check:

1. Record supporting data in accordance with the General Manual (Title 450, Part 407).

2. Plot ‘As-builts’ in red on plans, sign and date. Plot actual location of riprap on plan view and finished profile

3. Mark the Conservation Planning Map

4. Check off Practice on Conservation Plan and date completion.

5. Record in CON-6 Notes.

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

**Stream-bank Protection** -Minimum Design Content Class V - VII Jobs

**Drawings**

1. Plan View:

   a. Coverage of reach including existing topography upstream and downstream, significant trees, utilities, buildings, fences, pipes, tile unusual boulders and obstructions, other significant features, stream configuration including direction of flow.

   b. Perimeter of riprap to be installed showing tie backs at ends.

   c. Benchmark location and description.

   d. Access route to site.

   e. Location of soil borings taken (minimum of two).

   f. Bar scale and north arrow.

   9. Boundary of area to be vegetated.

   h. Location of any buffer strips and/or tree and shrub plantings.

   i. Fish structures, if any.

2. Profile:

   a. Profile shall include:

   - Top of bank to be protected

   - Low bank (at least one point)

   - Water level at date of survey

   - Low stream bottom

   - Soil log

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

**Stream Protection** (Continued)

MINIMUM CONTENT CLASS V - VII JOBS

3. Cross Sections:

   a. Minimum of two cross sections to depict representative cuts and fills required.

   b. Show riprap section and finished fill surface above riprap, bedding or filter features, vegetation limits, etc.

   c. At least one cross section shall show the full channel cross-section to beyond the top of the opposite bank.

4. Miscellaneous Details:

   a. Typical tie back details - use standard detail with site values entered.

   b. Other details as may be required to convey special features to the installer.

   c. Vicinity map showing site location.

5. Construction Notes:

   a. Provide key trench and bank finishing information.

   b. Reference the end tiebacks.

   c. Note that construction inspection shall be carried out as per the inspection plan if a formal contract or according to this guide for all other conservation practices.

   d. Specify the rock gradation for the riprap.

   e. Specify the bedding or filter gradation if required.

   f. List the required construction and material specifications by number.

6. Tabulate each construction item and list the estimated quantity for each.

7. Other:

   b. Identify engineering job class above title block.

   b. Identify Standard VT580 hazard class above title block.

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

**Stream Protection** (Continued)

MINIMUM CONTENT CLASS V - VII JOBS

c. Complete title block: - Practice - Landowner - Town, State - Identify designer, checker, etc.

**Specifications:**

1. Complete "Construction and Material Specifications Table of Contents" (Form Misc.-B).

2. Include "General Requirements" (Form Misc.-A).

3. Include all construction and material specifications checked on table of contents (Form Misc.-B).

**Cover Sheet**

4. Prepare cover sheet for design listing number of drawing sheets (Form VT-ENG-3).

**Design Computations and Back Up:**

1. Design Folder: A folder of the design is to be prepared which will contain:

   a. Design report (see sample).

   b. The completed design.

   g. All data gathered to develop the design

   h. Design analyses:
   - Environmental considerations
   - Hydrology
   - Hydraulics
   - Rock sizing
   - Filters or bedding
   - Other

   i. Bid Schedule (if formal contract)

   j. Construction performance time estimate (if formal contract)

   k. Inspection plan (if formal contract).

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

**Stream Protection** (Continued)

MINIMUM CONTENT CLASS V - VII JOBS

- Quantity computations

h. Operation and Maintenance Plan.

**Final Check:**

1. Record supporting data in accordance with the General Manual (Title 450, Part 407).

2. Plot 'As-builts' in red on plans, sign and date.

3. Mark the Conservation Planning Map

4. Check off Practice on Conservation Plan and date completion.

5. Record in CON-6 Notes.

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## ORGANIC MATTER FILTER BED (Code 193)

**Purpose** - To properly treat and dispose of milk-house wastes so as to reduce surface and ground water pollution and protect air quality.

### Information Required:

1. Sketch showing the general area including such things as the milk-house, farm lanes, power lines, watercourses or other features that may impact the design.

2. A survey to show the topography, source of waste and other pertinent physical features. Include enough area to show needed surface water diversions and subsurface drain outlets.

3. At least one plotted profile and one plotted cross-section of the area where the Organic Matter Filter Bed is to be constructed. Profile should include entire flow path of wastewater from the source to the Organic Matter Filter Bed.

4. Soil borings to determine soil texture, depth to water table and depth to bedrock.

5. Daily volume of wastewater to be treated, in gallons.

### Design Procedure:
(VT-ENG-16)

1. Determine the: soil profile number; soil condition and disposal area rating from Table 1, AWMFH, Amend VT-3, page 10-66.4. Record on Form VT-ENG-16.

2. Record the actual daily flow of wastewater (gpd) on VT-ENG-16.

3. Calculate the design flow by multiplying the actual flow times a flow multiplier. Use a flow multiplier of 3.0 or calculate using Table 4-6, AWMFH, page 4-9 with the equation in AWMFH, Amend. VT-3, page 10-66.2. Record on VT-ENG-16.

4. Calculate the required bed area using the design flow and a bed-sizing factor. The bed sizing factor is determined using the disposal area rating with Table 2, AWMFH, Amendment VT-3, page 10-66.4.

5. Calculate the selected bed size. The bed can be square or rectangular depending on site conditions. Under no circumstances should the bed be less than 40 feet long. Record the dimensions on VT-ENG-16.

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## ORGANIC MATTER FILTER BED (Continued)

6. Prepare construction drawings. Include the plan view, one or more cross sections, design data, construction notes, soil boring logs and estimated quantities. Also include detailed drawings of appurtenances such as; settling basins, grease traps, transfer pipe, blow-off valves and distribution boxes.

7. Prepare bill of materials.

8. Assemble appropriate construction and material specifications.

9. Check for location of public and private utilities in accordance with Part 503 of the National Engineering Manual. Place caution statement on drawings.

### Construction Layout:

1. Locate and stake diversions, subsurface drains, wastewater delivery lines and other system components.

2. Set top of cut stakes with cuts marked for required excavations.

3. Set grade and alignment stakes for the transfer pipe, grease trap distribution box and other structural features.

4. Coordinate all staking with the contractor and landowner to assure efficient use of manpower.

### Construction Inspection:

1. Arrange for a pre-construction conference. Those present should include the landowner/operator, the contractor or his/her representative and the NRCS person(s) responsible for providing assistance during construction. Review the role each of the parties involved in constructing the practice (see Misc.-A of Construction and Material Specifications for Conservation Practices). Review the drawings and specifications on the site and be certain there is a good understanding of them by the landowner and contractor. Be sure the landowner knows of construction elements critical to having NRCS on site concurrence.

2. Visit the site regularly during construction. Maintain a record of dates and times of visits, observations of problems, workmanship, progress, instructions and advice given and received and any other information bearing on the quality or efficiency of construction. Record in Job Diary or SCS-CPA-6.

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## ORGANIC MATTER FILTER BED (Continued)

3. Check site preparation, including stripping of topsoil and removal of structures or debris.

4. Inspect materials in the excavation to assure they conform to those shown on the design. If they are different, consult the designer for acceptability or design changes.

5. Check for unforeseen ground water seepage. Consult with designer for adjustments to design as necessary.

6. Make certain that the infiltration bed area is loosened after final grading with a chisel plow or harrow to remove the major compaction caused during construction.

7. Observe the bark or other organic matter being installed. No equipment travel should be allowed on the bed except the bulldozer used to spread the organic matter. The dozer must be kept on the in-place organic matter at all times pushing fresh material forward.

8. Check installation of the settling tank and/or grease trap, transfer pipe and other appurtenances for location, grade, materials and other important factors.

9. Check the finished elevations and dimensions. Make sufficient progress checks to prevent gross errors.

10. Check installation of drainage systems, diversions, fencing, seeding, access roads and other component practices.

### Final Check:

1. Record the as-built geology of the completed organic matter filter bed. Classify the soil materials from 0 - 2 feet of depth at the four corners and center of the infiltration bed using the Unified Soil Classification System. Map soil boundaries where classification changes occur. Record to scale on the plan and section views of the construction drawings in red pencil or ink and note as "as-built".

2. Record supporting data in accordance with the General Manual (Title 450, Part 407).

3. Plot ‘As-builts’ in red on plans, sign and date. Plot finished elevations on design cross-sections and spot elevations on plan view.

4. Mark the Conservation Planning Map

5. Check off Practice on Conservation Plan and date completion.

6. Record in CON-6 Notes.

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## **EMBANKMENT POND** (Code 378 EFH, Chapter 11)

**Purpose**: To provide water for livestock, fish, wildlife, recreation, fire control, etc.

**Limitations** - Class (a) dams where the product of the storage, in acre-feet, times the effective height of the dam, from the crest of the auxiliary spillway to the lowest point on the profile, is less than 3000.

### Information Required:

1. Drainage area.

2. Excavate and log test pits for the foundation evaluation. Check for signs of poor stability, embankment suitability, excessive leakage, bedrock and high water. Obtain sample(s) for laboratory analysis as necessary to evaluate soil for sealing against seepage losses. Classify the soils using the Unified Soil Classification System procedure (see Chapter 4 of the Engineering Field Manual). (VT-ENG-14 or SCS-ENG-538)

3. Survey and prepare a topographic map of the site, including buildings, utilities, access routes and test pit locations. Enter town or other zoning setbacks, right of ways, property lines or other features having a bearing on the pond location.

4. Profile centerline of embankment, principal spillway and auxiliary spillway

5. Elev. and pool size at normal water level.

6. Purpose of pond.

### Design Procedures:

Forms Available: VT-ENG-1 - Time of Concentration and Peak Discharge
VT-ENG-2 - Flood Pond Routing
VT-ENG 14 or SCS-538 Soils Log Sheet
VT-ENG-15- Runoff Curve Number
VT-ENG-28a – Pond Design
RTSC-NE-ENG-660
RTSC-NE-ENG-664
Many more construction detail sheets in VT Forms notebook

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## EMBANKMENT POND (continued)

1. Calculate the principal and auxiliary design discharges (EFH, Chapter 2). Refer to Engineering Standard for Pond (378), Section IV, Vermont Technical Guide for required design frequencies. Complete Forms VT-ENG-1 and VT-ENG-15.

2. Check volume of pond to determine if state approval is required (>500,000 CF)

3. Develop a storage curve to determine Acre-free of storage above NWL (See page 11-65 EFH for a sample). A quick approximation can be made by multiplying the surface area (acres) of the pond at NWL, times the difference in elevation between the NWL and auxiliary spillway crest in feet.

4. Select the 24-hour rainfall (principal spillway) for the applicable storm frequency. See table on page VT-378-8, Section IV, Vermont Technical Guide.

5. Determine temporary storage in inches. Ac.-Ft. of storage above NWL X 12 = temporary storage in inches per acre for the drainage area (DA).

6. Determine required release rate from Exhibit 11-9, EFH page 11-68 (See example page 11-67). Exhibit VT-11-4 or Exhibit 11-4, pages 11-55a through 11-55c may be used as alternative methods. Complete VT-ENG-2.

7. Check weir flow using Figure 6-27, EFH, page 6-43

8. Increase head or riser size as needed to provide full pipe flow..

9. Design auxiliary spillway (formally Emergency Spillway)

   a. Use calculated peak discharge from auxiliary spillway. Subtract pipe flow if diameter of pipe is greater than 12 inches. From Exhibit 11-8 EFH, pages 11-61 through 11-63.

   b. From Exhibit 11-2, EFH, pages 11-53 through ll-54k, using auxiliary spillway design data, set design high water using appropriate Hp.

10. Set top of settled fill to 1.0’ above design high water. Use 1.5’ for ponds requiring state approval. Increase constructed fill height 10% to allow for settlement.

11. With top of embankment established, check pipe flow using actual length and head.

12. Complete RTSC-NE-ENG-660 or 664 as appropriate. A complete set of construction drawings and specifications prepared for the specific structure is required for ponds requiring state approval. Refer to Engineering Design Standard for Pond (378), Section IV, Vermont Field Office Technical Guide for design criteria.

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## EMBANKMENT POND (continued)

a. Show side slopes, top width, cut-off trench and all minimum dimensions.

b. Show location and dimensions of seepage control filter and drainage diaphragm. Criteria is found on page VT-378-3, Section IV, Vermont Field Office Technical Guide.

c. Show location and size of anti-seep collars if applicable, Collars shall be in accordancre with criteria found on page VT-378-9 in Section IV of the Vermont Field Office Technical Guide.

d. Note compaction requirements. Compaction requirements should reflect soil types.

14. Calculate earth fill volume from TSC-NE-ENG-1114, EFH, pages 11-56.1 through 11-56.5

15. Check for location of public and private utilities in accordance with Part 503 of the National Engineering Manual. Locate and describe on construction drawings.

### Construction Layout:

1. Stake embankment, auxiliary spillway and normal pool areas for clearing or clearing and grubbing.

2. Set witness stakes for embankment centerline.

3. Set slope stakes for toe of embankment.

4. Set cut stakes for auxiliary spillway.

5. Principal spillway stakes graded for cut. Locate seepage control filter and drainage diaphragm or anti-seep collars.

6. Provide drawings and specifications to landowner. Include seeding recommendations.

### Construction Inspection:

1. Inspect foundation of dam to insure all organic, previous, and other unsuitable materials have been removed.

2. Inspect core trench excavation to insure minimum depth and absence of any objectionable material. Check the back fill material to insure quality and compaction. Record final depth for as-built construction drawing.

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## EMBANKMENT POND - (Continued)

3. Inspect principal spillway to insure proper type and dimensions of material including pipe, anti-seep collars, connecting bands.

4. Where concrete is involved, check forming and placement of steel and concrete.

5. Check grades for base of riser, pipe inverts, collars, stilling basin, etc. Record on as-built construction drawing.

6. Inspect earth fill placement, method, equipment, moisture, and compaction.

7. Check elevation of emergency spillway, particularly level section.

8. Check elevation of normal water level and top of constructed fill including settlement allowance.

9. Check installation of trash guards, etc.

10. Check vegetative protection.

### Final Check:

4. Record supporting data in accordance with the General Manual (Title 450, Part 407).

2. Plot ‘As-builts’ in red on plans, sign and date. Record as-built geology of the completed facility. Classify the soil material from 0’ to 2’ of depth at important locations in the excavated portion of the pond. For rectangular shapes, show the center and the four corners of the bottom, and selected points on the slope. For round or irregular shapes, show the center and at least four toe points in the bottom. Map soil boundaries where classification changes occur. Record to scale on the plan view drawing of the facility in red pencil or ink and note as "as-built".

3. Mark the Conservation Planning Map

4. Check off Practice on Conservation Plan and date completion.

5. Record in CON-6 Notes.

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## **COMPOSTING** (Code 317-vt1)

**Purpose** - Animal waste management.

### Information Required:

1 Determine the source, quantity, and quality of the waste and supplements to be treated. Record the livestock size, including milkers, heifers, dry cows, horses, pigs, chickens, etc., the type and amount of bedding used, other materials including water added, and source and type of carbon materials.

2. Select a suitable site giving proper consideration to location from barns, topography, watercourses, soil limitations, access for delivery and shipping of materials, utilities, aesthetics, prevailing winds with respect to farmstead and neighbors, and management of the composting piles.

3. Survey and prepare a topographic map of the site. Show property lines, barns, wells, springs, utilities, watercourses and other important features. Use two foot contour intervals and a scale of one inch equals 40 feet or larger. Enter town or other zoning set backs, right of ways, or other features having a bearing on the composting location, such as the location of nearby residences, etc.

Note: Some cases may only require a simple cross section and profile survey.

4. Determine if the site is in an aquifer protection area and the location of the site with regard to existing wells and springs.

5. There must be assurance form the landowner/operator at the start of plan

### Design procedures:

Composting of organic material will be rapid (2 or 3 months) if properties of the material are maintained within specific ranges. The 2 most important properties are moisture content and carbon to nitrogen ratio (C/N). A reasonable range for moisture content is 40 to 65%, with a preferred range of 50 to 60%. A reasonable range for C/N is 20 to 40, with a preferred range of 25 to 30.

1. Avoid the installation of composting facility in sandy or gravelly soils (USCS: SP, SP-SM, SW, GP, GP-GM, GW) or directly over bedrock.

2. Consider installing a concrete slab for composting operation if soils are limiting. Consideration also has to be given to type of turning equipment available, the hauling equipment, the rutting potential, and the amount of foreign material allowable in the finished compost.

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## COMPOSTING (Continued)

3. Other soils materials will be suitable for a composting site provided that potential runoff from rainfall events are contained or treated.

   a. If runoff flows overland through a properly designed filter area.

   b. If runoff flows into a holding pond with a suitable utilization plan.

4. Determine the moisture content of the waste to be managed. If this is not within reasonable range, select an organic material that will bring the moisture content within the range desired. These materials may include hay, straw, sawdust, waste feed, dried leaves, paper products, and other absorbent, nontoxic organic materials.

5. Determine the C/N ratio of waste to be managed. If the C/N ratio is not within the reasonable range, select an organic material that will bring the C/N ratio within the range desired. These materials may include sawdust, shavings, paper products, garden waste, grass clippings, and possibly other non-toxic, high carbon materials.

6. Compute a 'recipe' for the compost operation. The recipe includes all the organic materials, including animal wastes and additives, in proper proportions, to produce a compost pile with the moisture content and the C/N ratio in the preferred range.

7. Decide how the composting process will be carried out. The most common techniques are by windrowing and turning or static pile and turning. Each of these methods requires monitoring the compost and timely turning to reintroduce oxygen and structure (see item 2 in Operation). Other methods include aerated piles and in-vessel composting.

8. Determine a minimum surface area for the composting operation. This will be a function of the volume of the recipe and the time anticipated for composting process (dependent of frequency of turning piles). The total area for composting will have to include space for equipment to turn the windrows or piles. The "operation" area should be about equal to the area that the compost material occupies. Additional area may be required for a curing period.

9. Establish a preliminary layout considering operation procedures including turning piles and drainage of rainfall.

10. Divert all clean water by use of diversions, waterways, roof gutters, or French Drains.

11. Compute cuts and fill volumes if grading of site or retention pond is required.

12. Review design and management plan with the owner. Include detailed discussions of operation, available materials, temperature monitoring, aeration and utilization.

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## **COMPOSTING** (Continued)

13. Prepare final drawings. Include the plan view, one or more cross sections, profile, design data, construction notes, soils data, and estimated quantities.

14. Check for location of public and private utilities in accordance with Part 503 of the National Engineering Manual. Place caution statement on drawings.

1 5. Attach appropriate construction and material specifications to the drawings

### **Construction Layout**:
(if site grading or retention pond is required)

1. Set top-of-cut stakes with cuts marked for required excavations.

2. Set toe stakes for dikes and embankments. Mark required fill heights with consideration for over-fill.

3. As earthwork progresses, set slope stakes as necessary to assure construction to line and grade.

4. Set grades for top of embankment and bottom of excavation for finish grading.

5. Locate and stake diversions, waterways, or other component practices.

6. Coordinate all staking with the contractor and the owner to assure efficient use of manpower.

### **Construction Inspection:**

1. Visit the site regularly during construction. Maintain a record of dates, and times of visits, observations of problems, workmanship and progress, instructions and advice given and received and any other information bearing on the quality or efficiency of construction. Use a job diary or SCS-CPA-6.

2. Carefully inspect materials in the cuts and fills to assure they conform to those shown on the design. If they are different, consult the designer for acceptability or design changes.

3. Check for unforeseen groundwater seepage- Consult with designer for adjustments to design as necessary.

4. Check finished elevations, dimensions and side slopes of embankments and excavations. Make sufficient progress checks to prevent gross errors.

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## COMPOSTING (Continued)

5. Check site preparation, including stripping of topsoil and removal of structures or debris.

6. Check installation of waterways, diversions, seeding, fencing and other component practices.

### Operation:

1 At the start of any composting operation, there is a trial period associated with finding the right mix (recipe) of the amendments, that will produce the quality of compost desired in the time frame acceptable to the owner. During this trial period, frequent visits by NRCS may be required to discuss material and operation options.

2. Ingredients for the recipe have to be well mixed for composting to occur rapidly. Moisture content and C/N ratio need to be uniform throughout the pile. One efficient way to accomplish this is to use a rear discharge manure spreader, which will mix the ingredients and also form windrows for compost management. Another way is to use a front-end bucket to mix the ingredients by turning several times together, then placing into a windrow. Several approaches can be used to mix materials for other composting configurations.

3. Monitoring the compost windrows or piles with a composting thermometer, oxygen (02) meter, or carbon dioxide ($CO_2$) is essential for effective management and rapid composting. Temperatures between 110° and 150° F' are necessary. Initially, temperatures will rise within the compost pile to 140° to 150 F° and higher. Turn the pile if it goes above 150° F because microbial activity suffers in the heat and they can die or become dormant. When the temperature starts to decrease, this is an indication that the oxygen levels are getting too low for the microorganisms to consume the organic material. This is when the pile needs to be turned to introduce oxygen and new structure (for porosity). The $0_2$ and $C0_2$ meters are similar tools. If $C0_2$ is greater than 8% or $0_2$ is less than 8% then the pile needs to be turned.

4. More frequent turning will be required in the early stages of the composting process. Monitoring will dictate timing, but about once a week or so will be required during the first month. Less frequent turning will be needed at the middle and end of the process. When temperatures no longer can be maintained greater than 110° F', then the compost pile is ready for curing and will not needed to be turned any more. Curing can occur at the composting site or at another location.

5. Curing the compost in an important step in obtaining a high quality material. Curing begins when the temperatures within the pile can no longer be maintained above about 110° F and can be considered complete when the temperature is about the same as the ambient air.

# GUIDE FOR DESIGN AND CONSTRUCTION OF CONSERVATION PRACTICES

## **COMPOSTING** (Continued)

### Final Check:

1. Record supporting data in accordance with the General Manual (Title 450, Part 407)

2. Plot 'As-builts' in red on plans, sign and date.

3. Mark the Conservation Planning Map

4. Check off Practice on Conservation Plan and date completion.

5. Record in CON-6 Notes.